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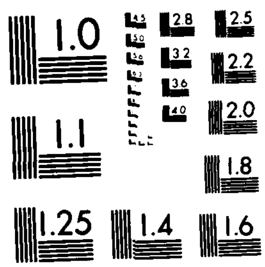

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
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Navigation Project-Southern California
Los Angeles-Long Beach Harbors Study

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This design memorandum was authorized for improving the navigation project in Los Angeles-Long Beach Harbors, California. It gives consideration to economic, environmental, social and pnysical conditions affecting the project. Public attitudes was without substantial controversy and therefore this plan of study was decided to be made.

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

LOS ANGELES - LONG BEACH HARBORS, CALIFORNIA

PHASE II

GENERAL DESIGN MEMORANDUM

LOS ANGELES HARBOR DEEPENING PROJECT

LOS ANGELES, CALIFORNIA

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Daniel Muslin
Project Manager

Los Angeles Harbor, California

Table of Contents

Figures

PLATES

APPENDIXES

LOS ANGELES - LONG BEACH HARBORS, CALIFORNIA
PHASE II
GENERAL DESIGN MEMORANDUM

LOS ANGELES HARBOR DEEPENING PROJECT

LOS ANGELES, CALIFORNIA

SYLLABUS

A plan of improvement for the harbor at Los Angeles, California, was authorized by the Water Resources Development Act approved October 22, 1976 (Public Law 94-587, 94th Congress), to provide for access of larger and deeper draft vessels into the harbor channels, in meeting the growing demand for additional marine oriented industry.

The District Engineer now submits a recommended plan of improvement which consists of deepening the entrance and inner harbor channels and basins of Los Angeles harbor to a depth of 45 feet below mean lower low water (MLLW).

Approximately 14.7 million cubic yards of dredged material would be removed from the authorized channels and disposed of within a 190 acre landfill on the seaward side of Terminal Island and an adjacent shallower water habitat.

The total cost for the improvement of the harbor facilities is estimated to be $59,125,000. The cost to the United States Government

for dredging the navigation channels is estimated to be $26,625,000. The time required to complete the general navigation features is estimated at 2-1/2 years.

Local interest would be responsible for all other improvements needed to complete the project.

The recommended plan deviates from the plan set forth in House Document No. 94-594 by altering the proposed disposal site to an adjacent area which would require less diking (rock work) than the original fill, the addition of two areas to be dredged for the purpose of navigational safety and the creation of the shallower water habitat area.

LOS ANGELES - LONG BEACH HARBORS, CALIFORNIA
PHASE II
GENERAL DESIGN MEMORANDUM

LOS ANGELES HARBOR DEEPENING PROJECT

LOS ANGELES, CALIFORNIA

PERTINENT DATA

Tide Data at Los Angeles harbor in feet (MLLW):

Mean Higher High Water	5.4
Mean High Water	4.8
Mean Tide Level	2.7
Mean Low Water	1.0
Mean Lower Low Water	0.0
Extreme Tidal Range	10.2

Proposed Project Data:

	Width	Length	Depth
Entrance Channel	1,000 - 2,450	5,500	45
Los Angeles Channel	750	12,500	45
Turning Basin (inner harbor)	1,350	1,650	45
East Basin Channel	400	6,000	45
West Basin	350-1,350	3,800	45
East Basin	400- 950	2,000	45

Project Purpose:

To facilitate deeper draft vessel maneuverability in the channels, safer passage and access to marine facility development in the harbor.

Estimated Costs and Benefit-Cost Ratio:

Federal First Cost	$27,760,000
Less Local Contribution	
for Land Enhancement	1,135,000
Non-Federal First Cost	32,500,000
Total Project Cost	$ 59,125,000
Annual Cost	
Federal	1,840,000
Non-Federal	2,240,000
Total	$ 4,080,000
Annual Benefits	14,300,000
Net Annual Benefits	10,220,000
Local Contribution	
(% of Federal First Cost)	4.1
B/C Ratio	3.5 to 1

PRIOR REPORTS

Title	Submittal Date	Approval Date
Phase I AE&D Study Classification Report and Plan of Study	April 1978	June 1978

LOS ANGELES - LONG BEACH HARBORS, CALIFORNIA
PHASE II
GENERAL DESIGN MEMORANDUM
LOS ANGELES HARBOR DEEPENING PROJECT
LOS ANGELES, CALIFORNIA

I-PROJECT AUTHORIZATION

1.01 AUTHORITY. This design memorandum is submitted pursuant to the Water Resources Development Act of 1976, Public Law 94-587, 94th Congress, 2nd Session, approved October 22, 1976, which reads in part as follows:

> Sec. 102. The following works of improvement for the benefit of navigation and the control of destructive flood waters and other purposes are hereby adopted and authorized to be prosecuted by the Secretary of the Army, acting through the Chief of Engineers, substantially in accordance with the plans and subject to the conditions recommended by the Chief of Engineers in the respective reports hereinafter designated.
>
> The project for navigation in Los Angeles-Long Beach Harbors, California: House Document Numbered 94-594, at an estimated cost of $16,850,000.

Giving consideration to economic, environmental, social and physical conditions, developments which have occurred, and public attitudes it was believed that the conditions of the project area and evaluation criteria have not changed since completion of the feasibility report. It was also believed that the recommended project, was without substantial controversy, except for the possible impact upon the least tern - an endangered species. Based on these considerations the decision to proceed directly from the Plan Of Study to this design memorandum was made.

1.02 PROJECT AS DESCRIBED IN PROJECT DOCUMENT. The plan of improvement for Los Angeles Harbor, California, which was recommended for approval in the Chief of Engineer's report dated 22 April 1975 was published as part of House Document No. 94-594, 94th Congress, 2nd Session. House Document No. 94-594, hereinafter is referred to as the project document. The plan set forth in the project document recommended that the existing project for Los Angeles harbor be modified to provide for deepening the present navigation channels and turning basins to the waterway dimensions shown below. A hydraulic pipeline dredge would remove material from the existing channels to a depth of 45 feet; the spoil would be placed behind rock-faced dikes built by the Port of Los Angeles. One-hundred eighty-seven acres of new land would be created, adjacent to Terminal Island. See plate 1.

Authorized Project Dimensions

	Width (feet)	Length (feet)	Depth (feet) MLLW
LOS ANGELES HARBOR			
Entrance channel	1,000	5,500	45
Los Angeles channel	750	12,500	45
Turning basin (inner harbor)	1,350	1,650	45
East basin channel	400	6,000	45
West basin	350-1,350	3,800	45
East basin	400- 950	2,000	45

The District Engineer further recommended Federal maintenance of the above dimensions. Over the life of the project (50 years), Federal maintenance is forecast to be insignificant. These recommendations were approved by Congress and authorized for construction in the Water Resources Development Act of 1976 (Public Law 94-587).

1.03 LOCAL COOPERATION SPECIFIED IN THE PROJECT DOCUMENT. The local cooperation specified in the project document and set forth in the authorizing legislation requires prior to construction, that local interests agree to (portions of the document are quoted):

- Provide without cost to the United States all lands, easements, and rights-of-way required for construction and subsequent maintenance of the project and for aids-to-navigation upon the request of the Chief of Engineers, including suitable areas determined by the Chief of Engineers to be required in the general public interest for initial and subsequent disposal of spoil, and also necessary retaining dikes, bulkheads, and embankments therefor or the costs of such retaining works;

- Hold and save the United States free from damages that may result from the construction and maintenance of the project;

- Provide and maintain at local expense adequate public terminal and transfer facilities open to all on equal terms;

- Provide and maintain without cost to the United States depths in berthing areas and local access channels serving the terminals commensurate with the depths provided in the related project areas;

- Accomplish without cost to the United States such alterations as required in sewer, water supply, drainage, and other utility facilities;

- Contribute in cash 4.1 percent of the Federal first cost of dredging the project channels, presently estimated at $399,000; such contribution to be made in a lump sum prior to construction;

- Establish regulations concerning discharge of pollutants in the waters of the harbors by users thereof, which regulations shall be in accordance with applicable laws or requirements of Federal, State, and local authorities responsible for pollution prevention and control;

- Prohibit erection of any structure within 125 feet of project channels and basins.

II-EXISTING CORPS OF ENGINEERS PROJECT

2.01 GENERAL. The existing Corps project was authorized by the River and Harbor Act of 1852 and subsequent River and Harbor Acts. The Los Angeles-Long Beach harbors project now constitutes the fifth largest port complex in the United States functioning as both a focal point for 7 million residents and a staging point between the United States and the Pacific basin countries. The completed parts of the authorized project consist of:

- A stone breakwater, 11,150 feet long (San Pedro Breakwater), extending eastward from Point Fermin.

- A stone and earth detached breakwater, 18,500 feet long (Middle Breakwater).

- A stone and earth detached breakwater, 13,350 feet long (Long Beach Breakwater).

- The maintenance of the original Long Beach Breakwater.

- An entrance channel 1,000 feet wide and 40 feet deep to Los Angeles Outer harbor.

- A turning basin, 3,500 feet long, 1,500 feet wide and 40 feet deep, opposite the end of Pier 1.

- The enlargement of the entrance to the Los Angeles Inner harbor by dredging to a depth of 35 feet, a triangular area at the junction of the inner harbor and the previously mentioned turning basin.

- Irregular anchorage areas (Areas A and B) 40 feet deep, adjacent to the Los Angeles Entrance Channel.

- An inner harbor channel (Los Angeles Channel), 35 feet deep and 1,000 feet wide.

- A turning basin at the north extremity of Los Angeles Channel, 35 feet deep.

- A channel (East Basin Channel), 35 feet deep and 650 feet wide, extending from the turning basin of the north end of Los Angeles Channel to Slip 5.

- A channel (Cerritos Channel), 35 feet deep and 400 feet wide from Slip 5 to a turning basin in Long Beach Inner harbor.

- The 35-foot deep Long Beach Inner harbor turning basin.

- An entrance channel to Long Beach Inner harbor (Long Beach Entrance Channel), 35 feet deep and 300 to 500 feet wide.

- A silt diversion channel (Los Angeles River) for protection of the harbors.

- A settling basin at the mouth of the diversion channel (dredged material to be deposited on the beaches eastward to Belmont Pier).

- Dredging in East Basin, Los Angeles harbor to a depth of 35 feet.

- Dredging in West Basin, Los Angeles harbor to a depth of 35 feet.

- Maintenance of the entire project except the silt diversion channel.

Dimensions of Waterways, Los Angeles, and

Long Beach Harbors, California

	Project Dimensions			Controlling Depth
	Width (Feet)	Length (Feet)	Depth (Feet) MLLW	March 1971
LOS ANGELES HARBOR				
Entrance Channel	1,000	5,500	40	40
Middle section of entrance channel*	500	4,100		51
West anchorage area (outer harbor)	1,900	5,000	40	38
East anchorage area (outer harbor)	2,100	10,000	40	40
Turning basin (outer harbor)	1,500	3,500	40	47
Los Angeles Channel	1,000	12,500	35	35
Turning Basin (inner harbor)	1,600	1,650	35	35
East basin channel and Cerritos channel	400-650		35	35
West Basin	variable	variable	35	35
East Basin	incomp.	incomp.	35	35
LONG BEACH HARBOR				
Cerritos Channel	400	6,000	35	50
Turning basin	1,100	1,600	35	55
Entrance channel	300-500	7,000	35	62

*Dredged by local interests.

The existing project is complete except for dredging approximately 700,000 cubic yards of material in the East Basin of Los Angeles harbor. On 20 April 1967, the Chief of Engineers reclassified the uncompleted portion of the project to a deferred category and was subsequently deauthorized in 1976.

2.02 MAINTENANCE. During the years, 1959 to 1970, the average annual Federal maintenance cost, all for reconnaissance and surveys, was $9,000. The last maintenance dredging was accomplished in April 1946 at a cost of $183,000. Repairs to the 12,500-foot Middle Breakwater were accomplished in December 1947 at a cost $786,700.

III-LOCATION OF PROJECT AND TRIBUTARY AREAS

3.01 DESCRIPTION OF PROJECT AREA. Los Angeles and Long Beach harbors form a single geographic and economic water terminal entity, serving the same hinterland but divided by a political boundary. The harbor, occupying a major part of San Pedro Bay, is approximately 25 miles south of the business center of Los Angeles, 370 nautical miles southeast of San Francisco Bay, and 95 nautical miles northwest of San Diego Bay. In its natural state, San Pedro Bay is a halfmoon shaped body of water protected on the west by the Palos Verdes - San Pedro Hills and entirely exposed on the southeast.

Santa Catalina Island, 25 miles offshore and San Clemente Island, 70 miles offshore, afford some protection on the southwest.

The manmade harbor is protected by a stone breakwater, 11,150 feet long (San Pedro Breakwater) extending eastward from Point Fermin, a rubblemound detached breakwater (Middle Breakwater) 18,500 feet long, and a rubblemound detached breakwater (Long Beach Breakwater) 13,350 feet long. Between the San Pedro Breakwater and the Middle Breakwater is a 1000-foot-wide entrance channel to Los Angeles harbor (Angeles Gate). Between the Middle Breakwater and the Long Beach Breakwater is an 800-foot-wide entrance channel to Long Beach harbor (Queens Gate). Various small islands, which once clustered about the estuarial complex of tidal sloughs, lagoons, and marshlands in the western part of the

bay, have been obliterated by the intermittent dredging and filling operations which created the existing inner harbor channels and Terminal Island. Terminal Island (3.5 miles by 1 mile), which shelters the inner harbor, is now the dominant feature of the port complex.

Los Angeles River, which drains an area of 832 square miles, ends its 50-mile flow in San Pedro Bay. Originally, the river flowed into Long Beach harbor complex and deposited great quantities of silt into the dredged channels of the Long Beach inner harbor during the rainy season. The Los Angeles County Flood Control District was formed in 1914. Under their local sponsorship, the Los Angeles River channel was relocated by the Corps of Engineers in 1923. The channel diverted the river flow to the east of the harbor into a large settling basin. The improved river channel has a design capacity of 146,000 cubic feet per second (cfs). The maximum discharge recorded near the present river mouth was 110,000 cfs on 25 January 1969.

The Los Angeles inner harbor is still the disposal point for floodwaters drained, from an 80 square mile area, by Dominguez Channel (a flood control facility constructed by local interests). The majority of this drainage area is urbanized, and development is continuing at a rapid pace. Because of the nature of the drainage area and the fact that the channel itself is concrete lined, wherever scouring velocities occur, this channel is not a major source of sediment; therefore, maintenance dredging of the Federal channels is not required.

a. Navigable Capacity. The entire San Pedro breakwater was originally constructed on the 50-foot contour line, so theoretically, there should be no natural depths greater than 50 feet in either harbor. In Los Angeles harbor depths vary from 16 to 50 feet. The Los Angeles entrance channel (originally 1,000 feet wide and 40 feet deep) was redredged by the Port of Los Angeles to a 500-foot width and depth of 47 to 51 feet to provide for the supertanker berth and bulkloading facilities. The main channel leads to the turning basin and thence to the east and west basins. These basins and channels are 35 feet deep.

The Long Beach entrance channel has been dredged by the Port of Long Beach to approximately 750 feet wide and 62 feet deep. The remainder of Long Beach harbor varies in depth from 18 feet to 70 feet. These extreme depths (70 feet) are attributable to the subsidence caused by subsurface volume reduction from oil pumping rather than overdredging. The subsidence problem has essentially been resolved by a water injection program where salt water is pumped to the underground cavities created by the pumping of oil. The channels in Long Beach harbor have operating depths of 45 to 65 feet. Cerritos Channel is 35 feet deep in Los Angeles harbor and 50 feet deep in Long Beach harbor. The surface area of the harbors is shown in the table below.

Principal Water Areas

Water Area	Estimated Size (Acres)
Los Angeles Harbor:	
Outer harbor	3,300
Inner harbor	950
Long Beach Harbor:	
Outer harbor	*4,100
U.S. Navy area	690
Inner harbor	160
Anchorage area east of outer Long Beach harbor	5,100

*Not including U.S. Navy area

b. Controlling Depths. As previously stated, no appreciable amount of silt is discharged into the developed sections of San Pedro Bay. Shoaling of the channels or basins is not a problem. Therefore, the controlling depths for the various basins and channels are the project depths except for those areas which have been deepened since construction of the existing Federal project.

3.02 **TOPOGRAPHY AND CLIMATE.** The Los Angeles harbor is in San Pedro Bay in the southwest region of the Los Angeles basin. The bay is a southern extension of the relatively flat coastal plain bounded on the

west by the Palos Verdes Hills, a structural block forming a stubby peninsula that offers some protection to the bay from prevailing westerly winds and currents. San Pedro Bay was originally an estuary of the Los Angeles River, composed of tidal marshes protected by an offshore bar. However, development of the Los Angeles - Long Beach harbor complex through dredging, fills, and channelization has completely altered the local physiography: the shoreline in both harbors is artificial, the offshore bar has been broadened to become Terminal Island, and the realined and channelized Los Angeles River forms the east boundary of the Port of Long Beach.

The harbor area has a mild, mediterranean climate. Most of the precipitation, which averages about 13 inches a year, falls from November through April. Fogs occur throughout the year and are most frequent at night. The winds are usually light; however, velocities sometimes reach 15 to 20 knots during summer afternoons.

3.03 BIOLOGICAL RESOURCES. The abundant marine life in the harbors includes such species of fish as white croaker, California tonguefish, speckled sanddab, white sea perch, queenfish, and shiner perch. The bay is important anchovy live-bait fishery and nursery ground, with northern anchovy inhabiting portions of the outer harbors of the ports. The diverse marine life also includes plankton, algae, sandy beach and rocky shore fauna, benthic (bottom-dwelling) organisms, and water column and fouling organisms.

Terrestrial wildlife at the harbors is limited because of the sparse vegetation and the disturbed habitat. The harbor is, however, an important resting and feeding area for coastal migratory water-associated birds from throughout western North America. Suitable nesting sites for water-associated birds are limited, but the California least tern, an endangered species, has nested on Terminal Island. The California brown pelican, also listed as endangered, rests on the breakwaters and jetties and feeds in the outer harbors.

3.04 CULTURAL RESOURCES. Although the harbor area has been altered considerably over the years and much of its cultural history has been lost, many of the structures or sites that were important to the history of the harbors still exist and have been designated as historic landmarks. The site of Timms Point and Landing is a California State Landmark, and the Ferry Building, Fireboat No. 2, and Firehouse 112 are Los Angeles Historic-Cultural Monuments. Some of the sites within the project area that are recommended for consideration as historical landmarks are the San Pedro Breakwater and Angels Gate Lighthouse, the Termial Island Schoolhouse, and the Municipal Fish Market. Descriptions of these and other cultural sites in the harbor complex are contained in the "Los Angeles-Long Beach Harbor Areas Cultural Resource Survey" published by the Corps in April 1978.

3.05 RECREATIONAL RESOURCES. The Port of Los Angeles affords recreational opportunities for sailing, boating, scuba diving, fishing, water skiing, swimming, and sightseeing. There are spaces for nearly 3,000 boats at the 16 small-craft marinas within the Port of Los Angeles. Ports O'Call Village, Whaler's Wharf, and the Rum Runner Restaurant offer specialty shopping and dining, and the Princess Louise Floating Restaurant features a maritime museum, entertainment, and dining. The Cabrillo Beach complex includes a public swimming beach, a launching ramp for small boats, a fishing pier, and a maritime museum.

3.06 TRIBUTARY AREAS. Los Angeles - Long Beach harbor serves more than one-quarter of the Continental United States. The tributary area comprises over 400,000 square miles in southern California, Nevada, Idaho, Utah, Arizona, Wyoming, Colorado, New Mexico, Texas and Oklahoma (see Figure 1), and contains about 9.6 percent of the nation's population.

The part of the tributary area east of the Continental Divide is primarily a source of export commodities. The part of the tributary area west of the Continental Divide is both a source of export commodities and a consumption area for the ports' imports. An important component of the consumption tributary area is that part of the area that lies within the State of California. This component had 78 percent of the population of the total consumption tributary area in 1970.

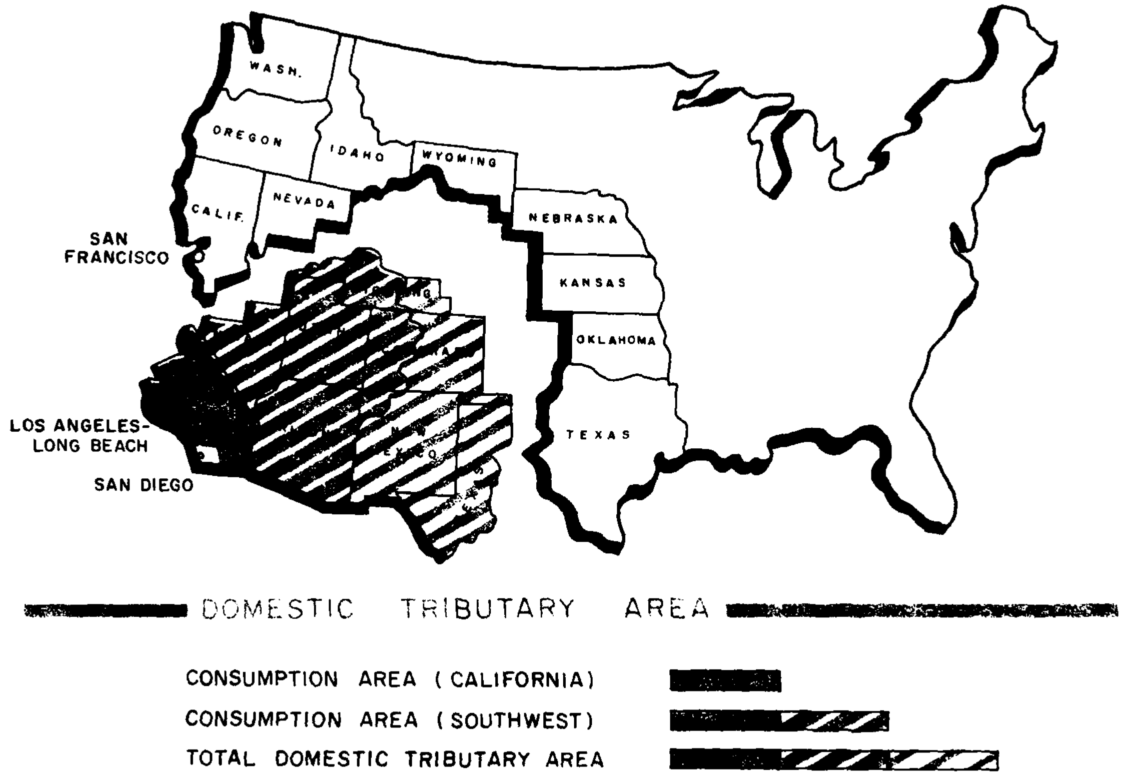

WASH.
OREGON
IDAHO
WYOMING
NEVADA
CALIF.
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
SAN FRANCISCO
LOS ANGELES-LONG BEACH
SAN DIEGO
DOMESTIC TRIBUTARY AREA
CONSUMPTION AREA (CALIFORNIA)
CONSUMPTION AREA (SOUTHWEST)
TOTAL DOMESTIC TRIBUTARY AREA

FIGURE 1.

a. Population. In 1970, the tributary area had a population of 19.3 million, of which 14.8 million lived within the consumption tributary area. The Los Angeles-Long Beach standard metropolitan statistical area, which is an important component of the consumption tributary area, is the second most populous urban area in the United States, ranking after New York and ahead of Chicago. Other standard metropolitan statistical areas in the tributary area, with their rank, are Anaheim-Santa Ana-Garden Grove, California (25th); Denver, Colorado (26th); Phoenix, Arizona (35th); and Salt Lake City, Utah (57th).

Present and projected population for tributary area components are shown in Figure 2. Projections are based on Office of Business and Economics Research Service (OBERS) projections and on State Series D 1970 projections for California.

b. Economy. In 1970, personal income in the consumption area totaled $60 billion (1958 dollars). The per capita income was $3,090, about 20 percent higher than the national per capita income.

In 1963-64, the total domestic tributary area contained almost 28,000 manufacturing establishments employing 1.2 million persons; the value added by manufacturing was over $14 billion. The tributary area also produced about $3.7 billion worth of minerals; and $3.5 billion worth of agricultural products.

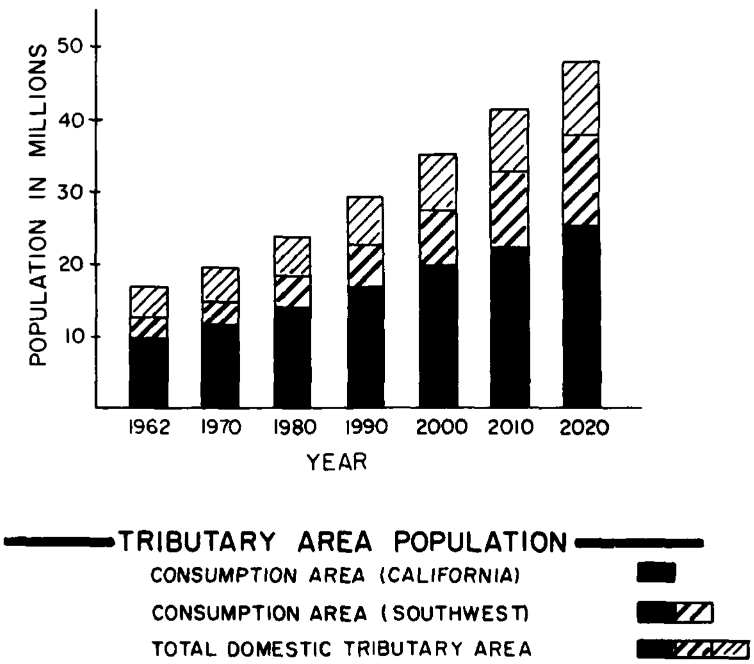

POPULATION IN MILLIONS
50
40
30
20
10
1962
1970
1980
1990
2000
2010
2020
YEAR
TRIBUTARY AREA POPULATION
CONSUMPTION AREA (CALIFORNIA)
CONSUMPTION AREA (SOUTHWEST)
TOTAL DOMESTIC TRIBUTARY AREA

FIGURE 2

The California component of the tributary area contained over 80 percent of the manufacturing establishments, was the most important in agricultural production, and led in the value of mineral production.

3.07 CHARTS AND MAPS. The area under study is shown on National Ocean Survey Charts 18751 and 18749 and on U.S. Geological Survey Quadrangles "San Pedro" and "Long Beach."

IV - LOCAL COOPERATION

4.01 PROPOSED LOCAL COOPERATION. The local cooperation requirements have been updated to reflect current cost estimates since authorization of the project. The requirements of local cooperation are as follows:

a. Provide, without cost to the United States, all lands, easements, and rights-of-way required for construction and subsequent maintenance of the Project and for aids to navigation upon the request of the Chief of Engineers, including suitable areas determined by the Chief of Engineers to be required in the general public interest for initial and subsequent disposal of dredged material, and also provide necessary retaining dikes, bulkheads, and embankments therefor or the costs of such retaining works;

b. Subject to Section 9, Pulic Law 93-251, hold and save the United States free from damages that may result from the construction and maintenance of the project;

c. Provide and maintain at local expense adequate public terminal and transfer facilities open to all on equal terms;

d. Provide and maintain without cost to the United States depths in berthing areas and local access channels serving the terminals commensurate with the depths provided in the re!ated project areas.

e. Accomplish without cost to the United States such alterations as may be required in sewer, water supply, drainage and other utility facilities;

f. Contribute in cash 4.1 percent of the Federal first cost of dredging the project channels presently estimated at $1,135,000. Such contribution shall be made in a lump sum prior to construction;

g. Establish regulations concerning discharge of pollutants into the waters of the harbor by users thereof, which regulations shall be in accordance with applicable laws or requirements of Federal, State, and local authorities responsible for pollution prevention and control;

h. Prohibit erection of any structure within 125 feet of project channels and basins.

By resolution No. 4322, on 3 January 1979, the Board of Harbor Commissioners of the Port of Los Angeles indicated their acceptance and willingness to meet the requirements of local cooperation (See Appendix A, Local Cooperation).

The Port of Los Angeles will be responsible for maintaining the 6-foot increase in channel depth to be accomplished by non-Federal dredging.

4.02 PRINCIPAL OFFICERS. The principal officers and representatives responsible for fulfilling items of local cooperation are the five members of the Board of Harbor Commissioners of the Port of Los Angeles, P. O. Box 151, San Pedro, California 90733. Their names and titles are as follows:

Frederic A. Heim, President

Jun Mori, Vice-President

Roy S. Ferkich, Commissioner

Mrs. Gene Kaplan, Commisioner

Benjamin N. Scott, Commisioner

V - DESCRIPTION OF PROPOSED STRUCTURES AND IMPROVEMENTS

5.01 RECOMMENDED PROJECT PLAN. The recommended plan consists of deepening and widening the existing harbor channels to allow deeper draft vessels to use the existing commercial facilities in the harbor. The channels will be deepened by approximately 10 feet, from -35 feet MLLW to -45 feet MLLW. The authorized project dimensions are in the following table:

PROJECT DIMENSIONS

	Width (feet)	Length (feet)	Depth (feet) MLLW
Entrance Channel	1,000 - 2,450	5,500	45
Los Angeles Channel	750	12,500	45
Turning Basin (Inner Harbor)	1,350	1,650	45
East Basin Channel	400	6,000	45
West Basin	350-1,350	3,800	45
East Basin	400 - 950	2,000	45

The details of the recommended project can be seen on plate 2.

5.02 **RECOMMENDED DISPOSAL OF DREDGED MATERIAL.** The project document required local interests to provide areas for disposal of dredged material, including necessary retaining dikes, bulkheads, embankments or the costs of such retaining works. The Port of Los Angeles has provided a disposal area in the Reeves Field area, located on the seaward side of Terminal Island, and will provide a retaining dike for approximately 11.7 million cubic yards of the dredged material from the harbor deepening project (See plate 2). The remaining 3 million cubic yards will be disposed of easterly of the landfill to create shallower water habitat.

A public meeting was held on 12 December 1977 in San Pedro, California, at which time the Corps of Engineers presented its proposed Los Angeles harbor deepening plans. The general manager of Los Angeles Harbor presented a plan for the disposal of the dredged material.

The recreational boating community and the California Department of Navigation and Ocean Development strongly opposed the harbor's plan because it would eliminate the possible use of the seaplane anchorage, adjacent to Reeves Field, as a small craft marina. Because of this opposition to the proposed landfill, a subsequent meeting was held between the Corps and the harbor department staffs. The meeting produced a change in the location of the proposed landfill to that now

recommended. The new proposal leaves the seaplane anchorage open.

5.03 PROPOSED STRUCTURES AND IMPROVEMENTS BY THE UNITED STATES. A minor departure from the project limits has been requested for navigation safety by the U.S. Coast Guard at the breakwater entrance approach (See Appendix B, Pertinent Correspondence). Improvements to be constructed by the United States with funds provided in the proportion of 95.9 percent by the United States and 4.1 percent by local interests would involve the above mentioned departure and the dredging of the channels as described in paragraph 5.01. The estimated amount of this dredging is 9,723,000 cubic yards which includes 1.5 feet of overdepth dredging. Aids-to-navigation will be provided by the U.S. Coast Guard at Federal expense. A typical cross-section of the channels is shown on plate 2.

The proposed harbor deepening project is consistent, to the maximum extent possible, with the California Coastal Plan, the Port of Los Angeles Draft Master Plan, and local land-use plans.

5.04 PROPOSED STRUCTURES BY LOCAL INTERESTS. The Corps of Engineers requires that local interests (Port of Los Angeles) design provide and maintain diking behind which the dredged material is to be retained. The retained material will create approximately 190 acres of new land at an approximate elevation of +24 feet MLLW on the south side of Terminal Island as shown on plate 2.

The first construction item to be initiated will be the 7,530 feet of retaining dike. Typical cross-sections are shown on plate 2. The dike will consist of a core of quarry run covered by a layer of "B" stone and heavy armor rock ("A" stone) on the exposed face. One or several overflow or weir discharge openings will be provided in the dike to control turbidity of the discharge water after it has pierced the water surface. It may also be necessary to use floating silt curtains to control turbidity by promoting settlement of the fines within a shorter distance from the discharge line. A plastic filter cloth may be placed on the back side of the rock to prevent leaching of fines into the tidal zone.

A 1000-foot long breakwater extending from the retaining dike eastward to contain and protect the shallower water habitat from wave action will be provided.

Additional dredging amounting to approximately 4,984,000 cubic yards will be accomplished under the same contract, but paid for by the Port of Los Angeles. These areas are shown on plate 2. This dredging to -45 feet MLLW will still remain 30 to 75 feet distant from the pierhead line as shown in plate 2. This dredging will be indistinguishable from the dredging done by the Corps previously described in paragraph 5.03. A widened and deepened approach to the supertanker and bulkloader berths at Berths 45 through 50 will also be accomplished. The Port will lower

the project depth to -51 feet MLLW, an increase of 6 feet.

The Harbor Department will be required to remove and relocate utilities as outlined in the local assurances. The plan for removal and relocation of utilities appears in Appendix C, Removal and Relocation of Utilities.

The Harbor Department recognizes the stability of their retention dike design and accepts the responsibility for it and absolves the Corps of Engineers of any damages arising from the construction.

VI - DEPARTURES FROM PROJECT DOCUMENT PLAN

The plan recommended in this design memorandum is identical in concept to the plan of improvement recommended in the project document. Minor departures from the project document resulted from moving the disposal site to an adjacent area west of the original location. The new fill would require less diking (rock work) than the original fill.

The creation of the shallower water habitat was added so as to lessen the impact on the least tern.

Another departure pertains to the U.S. Coast Guard's request to widen the entrance to the harbor for navigational safety.

VII - BASIS FOR DESIGN

7.01 GENERAL. Criteria and assumptions used in the design are in general agreement with published manuals, directives and with established practices of the Los Angeles District. The following paragraphs briefly indicate the scope of investigation.

7.02 TIDES AND CURRENTS. The mean range of tides in Los Angeles and Long Beach harbors is 3.8 feet and mean diurnal range is 5.4 feet. The extreme range is 10.1 feet and the elevation of mean sea level above mean lower low water, the plane of reference, is 2.8 feet. Tidal elevations in the inner harbors are virtually the same as those in the outer harbors.

Tidal currents are not of a degree to affect commercial ships in normal operations. A complete analysis of current and wave action within the bay has been made.

7.03 WEATHER. Extreme variations in weather are rare and the climate is generally mild. Severe ocean storms are seldom generated in the vicinity of Los Angeles and Long Beach harbors. Due to its limited fetch, the open area of the outer harbor is seldom affected by stormbred waves inside the bay. The same holds true for most of the area outside of San Pedro Bay. North and east are landward, west is protected to some extent by Point Vincente and Point Fermin; southwest is partially shielded by Santa Catalina Island (25 miles offshore), only the south and southeast

are completely exposed. The prevailing winds are westerly and southwesterly and rarely reach storm intensity. However, during the winter the ports are subject to infrequent southerly onshore winds which can cause some short period wave action in the bay. In the fall and early winter a "Santa Ana" condition sometimes occurs. This is actually a northeasterly desert wind (hot and dry) which can cause some short period waves at Cabrillo Beach but does not affect a major portion of the harbor.

7.04 CHANNEL DESIGN. In the design of the depth of channels, basins, etc., certain factors must be considered. These factors are:

Squat. Sinkage, or squat, is the term given to the hydraulic phenomenon which causes the lowering of the water surface immediately surrounding the vessel which, in turn, results in the lowering of the level of the vessel. It increases with higher speeds and decreases with an increase in the depth of water under the keel. Vessels loaded at an even keel or down at the bow produce greater ballast squat than corresponding stern squat. The amount of squat is dependent upon the speed of the vessel through the water, the distance between the keel and the bottom, the trim of the vessel, the cross-sectional area of the channel and whether the channel is located in a wide or narrow waterway, whether the vessel is passing or overtaking another vessel, the location of the vessel relative to the centerline of the channel, and the characteristics of the ship itself. Much attention has been given to this hydraulic phenomenon in two reports by the Corps of Engineers: Report

No. 3 of the Committee on Tidal Hydraulics, May 1965, "Evaluation of Present State of Knowledge of Factors Affecting Tidal Hydraulics and Related Phenomenon", and the "Review Report on the Channel to Newport News, Norfolk Harbor and Thimble Shoal Channel, Virginia", by the United States Army Engineer District, Norfolk, 1 March 1965. Application of the formula for squat developed by the Sogreah Laboratory at Grenoble, France (presented at XXth Congress of the Permanent International Associaton of Navigation Congress) would result in a computed vessel squat of about 0.5 foot. Actual tests performed in the Delaware River, a large open body of water, showed that the actual vessel squat was about 2.0 feet. Also, in tests performed for the Maracaibo Channel, Venezuela, which is 44 feet deep, 1,000 feet wide and with channel banks of 25 feet, the measured squat ranged from 1.1 to 2.9 feet for 25,000 to 35,000 dwt tankers. In the Norfolk District Report on the Thimble Shoal Channel an allowance of 2 feet was made for vessel squat. The channel depth and width recommended was 45 feet and 1,000 feet, respectively, both similar to those considered in this report. Based on these observations of similar conditions to those which could be expected for the channels considered in this report, an allowance of 2 feet has been made for vessel squat.

Trim. A vessel is often trimmed so that the stern is from 1 to 2 feet deeper than the bow. With the stern lowered, a vessel is given better handling characteristics and is allowed tc ride over the waves rather than plough through them. One foot has been allowed for trim

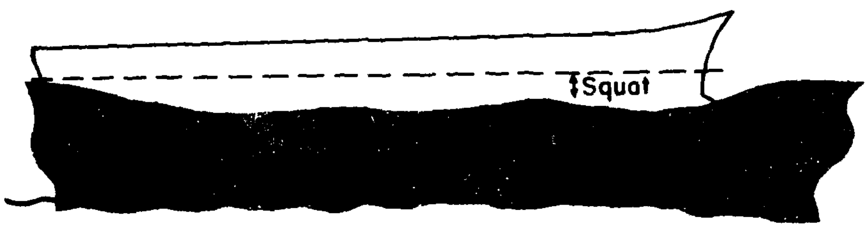
based on practical experience even though ETL 1110-2-209 Navigation Channels - Channels Depths dated 23 February 1976, recommends a greater distance.

Maneuverability. No precise determination of the effect of shallow water on steering is available, but it is generally recognized that a vessel becomes difficult to handle and requires large rudder angles. An allowance of 2 feet has been made in this report for maneuverability of the vessel and for pitching and rolling of the vessel.

The clearance considered necessary under the keel of deep draft vessels using the major channels of a port are shown graphically and summarized in figure 3.

Determination of Channel Widths. The Committee on Tidal Hydraulics considers the factors important to determining channel widths to be whether a passing situation exists, the vessel controllability, the vessel speed relative to the channel bottom, current velocities and direction, wave action, speeds and direction, the depth of water under the keel of the vessel, whether the channel occupies the entire waterway, and the characteristics of the channel banks. There is no formula which takes into account all of these diverse factors. Channel widths for Los Angeles harbor are based on the results of the investigations made during the study of the proposed sea level Panama Canal. The

Factors Affecting Channel Depth



Navigation Factor	Allowable Depth in Feet
Squat	2 feet
Trim	1 foot
Maneuverability	2 feet
TOTAL	5 feet

FIGURE 3

channel widths are computed in the following paragraphs and shown in figures 4 and 5.

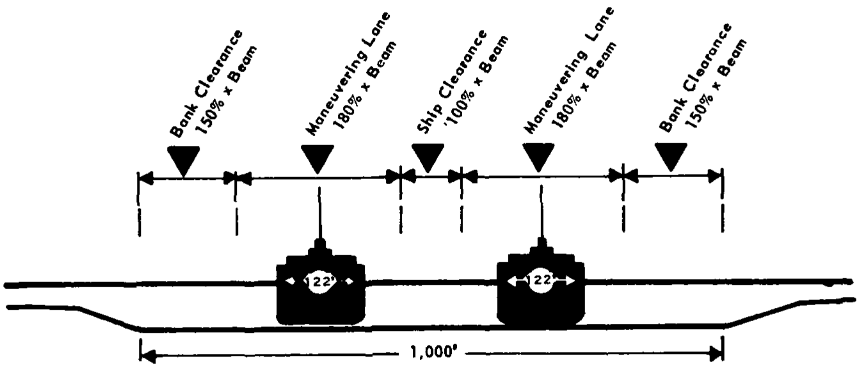
Since more than 6,000 ships use the Los Angeles and Entrance channels annually, a passing situation was used for channel width computations on those two channels.

Los Angeles and Entrance Channels. The improvements under consideration would require extension of and deepening of these channels. The design ships for channel width determinations only were: a 90,000 DWT ship with a beam of approximately 122 feet for the Entrance Channel; and for the Los Angeles Channel and East Basin Channel, a 60,000 DWT ship with a beam of 100 feet. Tabulations for the derivation of the channel widths follow:

Entrance Channel

Channel Elements	Derivation	Element Widths
Bank Clearance	150 percent of beam	183 feet
Maneuvering Lane	180 percent of beam	220 feet
Ship Clearance	100 percent of beam	122 feet
Maneuvering Lane	180 percent of beam	220 feet
Bank Clearance	150 percent of beam	183 feet
MINIMUM WIDTH OF CHANNEL		928 feet

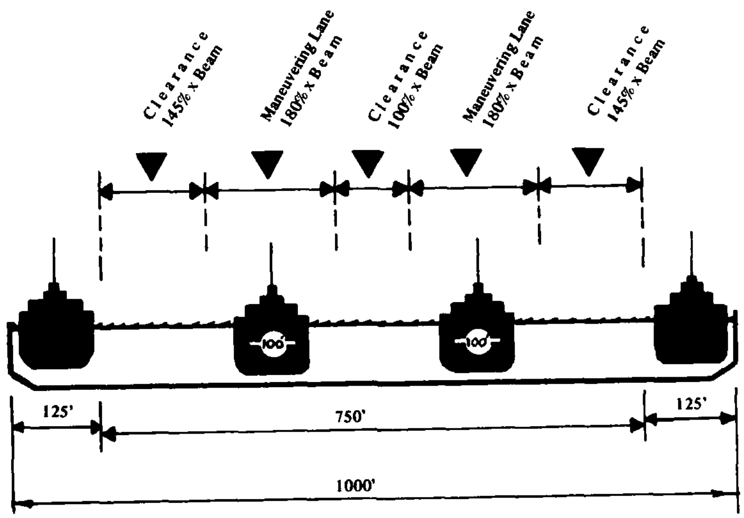
Channel Width Design



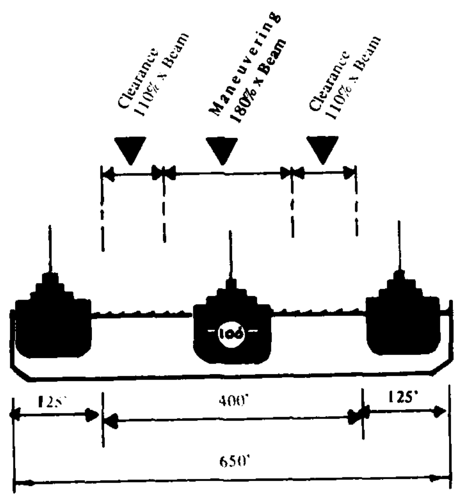
ENTRANCE CHANNEL - 90,000 DWT CARRIERS PASSING

FIGURE 4

Channel Width Design



LOS ANGELES CHANNEL - 60,000 DWT CARRIERS PASSING



EAST BASIN CHANNEL - 60,000 DWT CARRIER (NO PASSING)

FIGURE 5

Los Angeles Channel

Channel Elements	Derivation	Element Widths
Clearance	145 percent of beam	145 feet
Maneuvering Lane	180 percent of beam	180 feet
Ship Clearance	100 percent of beam	100 feet
Maneuvering Lane	180 percent of beam	180 feet
Clearance	145 percent of beam	145 feet
MINIMUM WIDTH OF CHANNEL		750 feet

East Basin Channel

Channel Elements	Derivation	Element Widths
Clearance	110 percent of beam of bulk carrier	110 feet
Maneuvering Lane	180 percent of beam of bulk carrier	180 feet
Clearance	110 percent of beam of bulk carrier	110 feet
MINIMUM WIDTH OF CHANNEL		400 feet

A 1,000 foot wide entrance channel was selected to provide vessels a margin of safety.

VIII - ALTERNATIVES

Alternatives to the deepening of the harbor were not considered in this report because of the detailed analysis performed on the alternatives in the authorizing document; however, an alternative to the disposal of the dredged material in the proposed landfill was investigated. The alternative investigation entailed the disposal of all of the dredged material at sea. It was assumed in this alternative that most of the dredging would be performed by a hopper dredge, except in the berthing areas where the material would probably be removed by a "clamshell" dredge. All of the material would be disposed of at an EPA approved disposal site, about 5.8 nautical miles southwest of the Los Angeles breakwater entrance. There would be no land created nor land enhancement benefits. It is estimated that the cost of this disposal would be $81,000,000. This alternative was rejected as being too costly to the Federal Government and unacceptable to local interests.

IX - ENVIRONMENTAL ANALYSIS

9.01 ENVIRONMENTAL IMPACTS. The following paragraphs summarize the direct and indirect effects resulting from the dredging and landfill operations.

SUMMARY OF IMPACTS OF DREDGING.

Direct Impacts

a. Minor temporary increases in turbidity, decreases in dissolved oxygen, and increases in suspended and dissolved pollutants in the immediate vicinity of the dredge cutterhead.

b. Complex, synergistic effects from resuspended sediments on marine life immediately adjacent to areas to be dredged.

c. Destruction of existing benthic marine life in the areas to be dredged.

d. Temporary contribution to the degradation of air quality in the South Coast Air Basin.

e. Disruption of marine traffic during construction.

f. Temporary annoyance created by increased levels in noise during construction.

Indirect Impacts

a. Reduction in chronic turbidity, increase in dissolved oxygen levels and decrease in suspended and dissolved pollutant levels due to the removal of contaminated sediments and a reduction in their re-

suspension by ship traffic.

b. Minor reduction in Harbor flushing and circulation.

c. Changes in benthic community composition due to altered sediment characteristics in areas to be dredged.

d. Improved navigational safety in Los Angeles harbor following dredging.

e. Air quality benefit derived from harbor deepening and associated increase in vessel size, decline in frequency of vessel calls, and reduction in lightering activity.

f. Socio-economic impacts resulting from expected increases in trade and accompanying primary and secondary effects on employment.

g. Increased availability in the harbor of docking and loading facilities, which should alleviate some of the pressure for general cargo facilities elsewhere along the California coastline.

SUMMARY OF IMPACTS OF LANDFILL

Direct Impacts

a. Increase in turbidity, decrease in dissolved oxygen, and increase in suspended and dissolved pollutants in the areas immediately around the landfill overflow point(s) and during the construction of the shallower water habitat.

b. Complex, synergistic effects from resuspended sediments on marine life immediately adjacent to the landfill overflow point(s).

c. Irretrivable loss of existing habitats and non-mobile organism in the area to be filled.

d. Elimination of resting area (from removal of sunken hulks in proposed fill area).

e. Displacement of fish from the area to be filled.

f. Creation of artificial food source for birds at discharge point.

g. Temporary contribution to the degradation of air quality in the South Coast Air Basin from construction equipment operation.

h. Change in visual character of outer harbor from replacement of 8% of present open water area with landfill.

i. Significant disturbance of the endangered least tern nesting and feeding areas.

Indirect Impacts

a. Relocation of impacts from Terminal Island Treatment Plant (T.I.I.P.) outfall to new area of outer harbor.

b. Temporary creation of 190 acres of terrestrial habitat.

c. Alteration of outer harbor circulation gyre.

d. Alteration of existing habitats with a net increase in other harbor biomass.

e. Creation of protected least tern nesting site on the landfill.

f. Creation of shallower water habitat to the east of the fill site.

g. Economic benefits from creation of 190 acres of developable land in the harbor.

h. Savings in transportation costs due to increased efficiency of larger vessels.

i. Potential adverse changes in air quality due to emission sources associated with future development and operation of facilities on the proposed landfill.

No presently recorded archeological sites will be impacted by the dredging and landfill activities, and it is expected that no cultural resources in the project area will be affected by these activities. A detailed study is underway to verify these statements.

9.02 ADVERSE ENVIRONMENTAL EFFECTS: The following effects are considered to be significantly adverse:

(a) the loss of marine habitats especially in the area of the landfill;

(b) possible dispersion of pollutants from sediments to be dredged;

(c) the disruption of the least tern, an endangered species.

9.03 MITIGATION: As a result of extensive coordination between the Corps, the Los Angeles Harbor Department, the U.S. Fish and Wildlife Service, the National Marine Fishery Service, and the California Department of Fish and Game, a mitigation plan has been

developed which alleviates potential adverse impacts of habitat losses as well as adverse impacts to the California least tern. The plan provides for protected nesting sites for the endangered California least tern during and post construction, creation of a shallower water habitat, and funds to study the least tern in the harbor. The Corps was not authorized to cost share mitigation measures for this project which local interests are willing to provide; therefore, no cost sharing is shown.

9.04 MODEL STUDIES. The U.S. Army Engineer Waterways Experiment Station performed tidal circulation and harbor oscillation tests for the proposed plan of improvement along with a proposed outer Long Beach harbor oil terminal adjacent to Pier J. The purpose of these tests was to investigate the effects the proposals might have on other features of the harbors.

9.05 TIDAL CIRCULATION. A detailed discussion of this investigation is contained in Appendix D, Tidal Circulation Tests. The proposed harbor expansion plans for the Long Beach outer harbor oil terminal (adjacent to Pier J) and the Los Angeles harbor deepening project considered in this study resulted in minor overall changes to the net circulation as compared with existing conditions. Although tidal currents were significantly affected near the oil terminal and in the dredged areas, the net discharges through the harbor entrances and through Cerritos Channel were not significantly changed. Specific changes in tidal circulation produced by the proposed expansion plans were:

a. Small increase in net flow into the harbor through the Los Angeles and Long Beach harbor entrances.

b. Small increase in net flow out of the harbor at the east end.

c. Negligible effect on the net westward flow in Cerritos Channel, but with a decrease in maximum velocities in the dredged area due to the increased channel depth.

d. Little effect on tidal circulation patterns east of the Long Beach harbor entrance except near the proposed oil terminal.

e. Little effect on tidal circulation in the Los Angeles and Long Beach outer harbor area except near the proposed Long Beach outer harbor oil terminal and the Los Angeles harbor landfill.

9.06 HARBOR OSCILLATION. A detailed discussion of this investigation is contained in Appendix E, Harbor Oscillation Tests. Wave-height amplification in the Los Angeles and Long Beach harbors was not substantially altered by the proposed plan. The resonant peaks which increased significantly were in the shorter period range and occurred over a narrow period band. Only a small amount of energy in the incoming wave spectrum would be contained in the narrow period range of the peak and the sharp, narrow peaks should have a relatively small

affect. The broad resonant peaks in the existing area of the harbor are similar or generally decreased in the longer period range. Specific conclusions from comparisons of two wave data for existing conditions and for the proposed plan are:

a. Resonant periods in the model and prototype agree for existing conditions.

b. Wave-height amplification in existing berthing areas has generally not changed significantly or has decreased (the 96-second oscillation in East Channel, for example).

c. In Southeast Basin (Long Beach harbor), resonant amplification at several periods increased but remained lower than the resonant amplification for existing conditons at nearby periods.

d. Ship mooring conditions should not be adversely affected in the existing harbor by the Modified Phase I plan with the possible exception of Southeast Basin where the response of moored ships resonant to shorter periods (40- to 60-second range) may increase.

e. Of the six resonant modes of oscillation which developed in the proposed Long Beach Outer Harbor Oil Terminal, only one mode (96 second) had a node located near an oil terminal berth. Amplification at

96 seconds is relatively low and ship mooring conditions should be satisfactory provided the ship does not respond significantly to a period near 96 seconds.

Wave-height amplification and resonant modes of oscillation for existing conditions and the Modified Phase I plan have been determined in the hydraulic model study. Moored ship response is a function of the ship response to incident wave amplitude and period and the incident wave spectrum, as well as the response of the harbor to wave excitation. The results of the model study may be used in a comprehensive study of moored ship response to draw conclusions on the precise degree of ship motion in Los Angeles and Long Beach harbors.

9.07 SECTION 404(b) EVALUATION. Section 404(b) of the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500) requires the Corps of Engineers to evaluate proposed deposition of material into waters of the United States. The material to be deposited as part of the proposed project will be hydraulic dredge spoil. The sediments to be dredged are predominantly silty sand, with a surface layer of soft muck which is considered to be highly polluted. The majority of dredge spill will be placed in a 190 acre landfill site behind an enclosed dike. Clean sand and quarry rock will be deposited during construction of the dike. Clean sandy sediments will be deposited in a 190 acre site adjacent to the fill to produce a shallower water habitat.

All disposal operations will cause a temporary increase in turbidity. Associated with increased turbidity will be decrease in disolved oxygen concentrations, an increase in suspended and disolved pollutants and impaired visual quality of surrounding waters. The turbidity is expected to cause feeding interference to zooplankton community, which may temporaily alter food webs in the harbor. The disposal of most of the dredge spoil - including all the polluted sediments - behind the dike will help to reduce the impacts of turbidity. Silt curtains will be used as necessary to meet water quality requirements.

The benthic community within the 190 acres of fill and 190 acres of shallower water habitat will be destroyed. The habitat area is expected to recolonize rapidly. The composition of the substrate will shift toward more sandy material with a lower pollutant load.

No existing wetland habitat will be effected by the filling.

X - ECONOMICS

10.01 GENERAL: Predictions of trends in vessel size indicate that general cargo vessels, with the exception of container vessels, are expected to stabilize at a draft compatable with existing channels. Therefore, the only general cargo vessels that will require greater channel depths are container ships, which are expected to stabilize at drafts of 39-42 feet. Scrap metal is shipped from the inner harbor in bulk cargo vessels. Shippers of this commodity indicate that they will lease ships with the maximum efficient draft for whatever channel is made available to them. Such ships are already available in the world fleet.

The economic evaluation did not look at optimizing the project at 45 feet MLLW due to General Connell's comment on page 4, paragraph 5 of a letter dated 6 September 1977 entitled " District Position on Los Angeles - Long Beach Harbors (Los Angeles Harbor Deepening) Project, which states in part "Benefits will be determined by indexing values shown in the authorizing document as routinely developed for program development purposes". Since a straight indexing would increase benefits in proportion for all depths, the benefits would be greatest for 45 feet MLLW, as they were in the authorizing document.

A review was made of the history of scrap metal operations at the Port of Los Angeles. It was determined that, in spite of their short

term cyclical nature, there is an overall increasing trend in their imports and exports. The inner harbor scrap metal terminals have the capacity to handle all bulk scrap shipped through the Port of Los Angeles. Container facilities in the Los Angeles inner harbor will be able to handle all projected container traffic until the year 2015 with the high cargo projections and the year 2020 with the low cargo projections. Thereafter, the container cargo handled in the inner harbor should continue at those levels. The Port of Los Angeles expects to develop additional container facilities to handle the remaining cargo at that time. Therefore, two types of cargo will provide the benefits for the project - containerized general cargo and scrap metal. No benefits are assumed for domestic shipments or receipts of general cargo since the container ships used on these short runs are small enough to use the existing channels without difficultv.

The low projection of commerce through the Los Angeles harbor was used in this analysis.

10.02 CALCULATIONS OF COSTS. The costs associated with the deepening of the inner harbor channels consist of the Federal and non-Federal cost for deepening the channels and the cost to local interests for utility relocations and retention works for disposal of the material. The costs have been figured for channels with depths ranging from the present depth to the maximum depth allowed by the structures along the inner harbor channels.

In addition, the manner and siting of dredge disposal is a matter of concern because of its economic effect. The recommended plan assumed two 27-inch hydraulic cutterhead pipeline dredges, with booster pumps, and deposits the spoil behind port-constructed dikes. The estimated dike cost would be $13,000,000, providing 190 acres of new land created contiguous with Terminal Island. This method has been used successfully by the Ports of Long Beach and Los Angeles and proven to be economical. The deposited spoil becomes new harbor land and a potential revenue producer, qualifying for land enhancement benefits. The average unit dredging cost is estimated to be $2.67 per cubic yard.

10.03 TRANSPORTATION SAVINGS. The benefits are those to be derived from the savings to shippers through the use of larger scrap and container vessels and from land enhancement benefits resulting from the utilization of dredge spoil for the recreation of new waterfront land in the outer harbor. The project life was considered to be the 50 year period beginning in 1980.

The benefits have been calculated for deepening the channels from the existing depth (35 feet) to a depth of 45 feet. The savings to shippers were calculated by determining the difference between the cost of shipping cargo in the most efficient ship which can enter the present 35-foot channel and the cost of shipping cargo in the most efficient

ship which can be used for the proposed channel depths. In all cases, the ship had a draft of 5-feet less than the depth of the channel to allow for necessary clearances beneath the keel. The relative costs per ton for shipment by various sized container and scrap carrying vessels over 5,500-mile, one-way, trip with a 24-hour turnaround time for the container ships and a 36-hour turnaround time for scrap carriers were used. The 5,500-mile, one-way trip represents the distance from Los Angeles to Japan. The 1970 Port of Los Angeles records indicate that all vessel trips for these commodities are at least that long with the majority of this cargo actually going to Japan. The above costs are based on July 1977 statistics compiled by the Transportation Economics Section of the Office of the Chief of Engineers, with the exception of scrap iron vessels. For scrap vessels, the January 1977 operating cost of dry bulk foreign flag vessels was used. Nearly all foreign cargo passing through the Port of Los Angeles is carried on foreign flag vessels. Therefore, only foreign flag vessel costs were considered.

10.04 ALTERNATIVE DEEPENING SCHEMES: There appears to be no practical solution to the problem of handling the expected future cargo tonnages without deepening the Los Angeles inner harbor channels. If all future cargo is to be carried by ships small enough to utilize the existing channels, the berthing facilities cannot handle the future cargo. The minimum turnaround time for a container vessel regardless of its size is 24 hours. With deeper channels and larger ships, no appreciable in-

crease in the number of ships to be berthed would occur, and the existing facilities, including those under construction at the present time, could be expected to handle the increased cargo.

Since the projected container and scrap tonnages could not be handled by the Los Angeles facilities without deeper water, the excess cargo would have to be diverted to another port. The ports of the Pacific Coast including the Port of Long Beach have been evaluated, and there is no available existing port that could handle the projected cargos without alterations at least as costly as the deepening of the Los Angeles harbor channels. One other alternative, that of deepening only the entrance channel and an anchorage area for large ships and lightering the cargo from the anchorage area to the existing berths, was also analyzed. Shipping agents and stevedore company representatives indicate that unloading containers and/or scrap from a large ship to a smaller ship in the outer harbor would not be practical due to the nature of the specialized equipment which must be used to handle these cargos. The movement of the vessels would be too excessive to permit the proper use of a container crane and could cause the loss of cargo over the side of the vessel. Even if the possibilities of loss of cargo, water pollution, and injury to cargo handling personnel were ignored, they estimate that the lightering of these cargos would cost approximately three times as much as bringing the ships to dockside for unloading.

There are three possible alternate schemes for deepening some Los Angeles inner harbor channels without deepening all of the inner harbor channels. They are as follows:

a. Alternative 1 - Deepening only the Entrance Channel and Los Angeles Main Channel. This alternative would only benefit container shippers with berths located on Los Angeles Channel (37.5% of the container traffic).

b. Alternative 2 - Deepening all inner harbor channels except East Basin. This alternative would benefit all container shippers except those along Cerritos Channel (75% of the container traffic). It would not result in any transportation benefits for scrap shipping.

c. Alternative 3 - Deepening all of the inner harbor except West Basin. This would benefit the shippers of scrap and all container shippers except those located in West Basin (62.5% of the container traffic).

Since all of these partial projects are justified, each could stand alone as a justifiable project. However, none of the partial projects approaches the benefits of the total project so it does not seem proper to recommend the deepening of only a small portion of the harbor.

10.05 BENEFITS: The estimated high and low annual benefits for a channel depth of 45 feet are $15,600,000 and $14,300,000 respectively,

using an interest rate of 6-5/8%. Due to the uncertainties involved in projecting cargos and fleets over a 50-year period, it seems prudent to use the most conservative results found. Therefore, the benefits for this project were determined from the results of the low calculations. The annual cost of the project, at 6-5/8% is $4,080,000 resulting in a benefit-cost ratio of 3.5 to 1.0. A breakdown of the annual costs and benefits is shown in the Estimated Costs table.

XI - GEOTECHNICAL INVESTIGATIONS

11.01 GENERAL. A detailed analysis of the geology and soil conditions for the harbor deepening project was performed. Appendix F, Geotechnical Investigations, contains a detailed discussion of this analysis. A summary of the studies performed is contained in the following paragraphs.

11.02 SUMMARY. The estimated quantity of materials to be excavated for this project is 14.7 million cubic yards. The table below presents, for estimating purposes, the approximate quantity of each type of material in the required excavation.

ESTIMATED QUANTITY OF MATERIALS TO BE EXCAVATED

Material	Quantity (million cubic yards)
1. Unconsolidated sediments	
a. Surface sediment (muck)	2.6
b. Sand/silty sand (SP & SM)	5.6
c. Silt/clay (CH,MH,CL & ML)	4.0
2. Bedrock (clay-shale)	2.5
TOTAL:	14.7

Because of the extreme variance in the materials to be excavated, in the proposed channel deepening, dredging conditions will also vary. The surface sediment is soft, frequently soupy and has a high silt or clay content although some sand exists. The muck varies in thickness from zero in the center of the channel to as much as 8 feet along the borders. Its greatest extent is in the inland waterways north of Reservation Point, although a lesser amount occurs in West Basin. Bottom sediment analyses indicate the overall concentration of heavy metals (zinc, lead, mercury and cadmium) and oil and grease is very low. Where significant levels of the chemicals do occur, it is usually in the surface sediments in portions of the Main Channel and particularly in the East Channel and East Basin. Dredging of the loose surface sediments is likely to encounter trash and scrap along the channel borders, particularly in East Channel.

The unconsolidated natural sediments consisting of sands, silts and clays should pose little difficulty in dredging, although some of the clay strata may be a little more resistant. The level of chemical pollution in these strata is extremely low, especially in the sands and special requirements for their disposal (outside of turbidity from the silts and clays) would not be required. Based on previous experience, channel wall slopes of one vertical on two horizontal should be stable.

The clay-shale bedrock will be the most difficult of all the materials to dredge. The material is a very stiff and relatively massive clay which would excavate in chunks and would also cause high turbidity, especially in the disposal area. Dredging resistance of the bedrock would probably be greater in those areas off the south ends of Reservation Point and Pier One outside the existing channel. These areas require cuts of a much as 27 feet to reach elevation -47 feet MLLW. Although no test holes were drilled to the proposed grades, seismic profiling data indicate the bedrock changes little with depth. Dredging conditions should be consistent throughout the reach containing the bedrock from near buoy "4" in the outer harbor to an irregular line off the Coast Guard Station. In the shallower cuts up to 10 feet, vertical slopes in the bedrock should be stable. In the deeper cuts, slopes in the bedrock should be excavated no steeper than two vertical on one horizontal.

During the exploratory drilling, hard inpenetrable rock was encountered at two locations, immediately off the southwest corner of Reservation Point (test hole 78-52) and adjacent to the Coast Guard Station (test holes 78-31 and 46). The rock was encountered at or near the harbor floor and may be remnants of two old breakwaters which extended from the former Deadman's Island. If such is the case, the lateral extent of this rock will be very limited. These two areas will be further investigated prior to preparation of the plans and specifications.

Because of the variability in the excavated materials, the finer grained and more polluted portions (surface muck, trash and bedrock) should be disposed of prior to the coarser sediments. The most favorable sand deposits are towards the north side of West Basin, between Mormon Island and the Vincent Thomas Bridge and from berth 75 to the Coast Guard Station in the Main Channel. The latter area is the largest and contains the best sand of the 3 locations. If more sand is required than is available within the required depth of excavation, this area may be over-excavated to considerable depths for additional material.

11.03 MATERIALS SOURCES. A selection of sources capable of supplying suitable stone for the disposal area dikes is available. The quarries listed below are the most feasible, based mainly on hauling cost to the site.

a. The Connolly-Pacific quarry is located on the east end of Santa Catalina Island about 2 miles from Avalon. This quarry is one of the largest suppliers of stone for use in ocean projects in Southern California. Stone inspected in 1972 at the Los Angeles harbor detached breakwater remained sound after 38 years of service.

b. Another large supplier for ocean projects is the Graham Brothers quarry also located on Santa Catalina Island near the Isthmus. Stone from this quarry was used in Los Angeles harbor and is still sound after 35 years service.

c. The Harlow quarry is located in Temescal Canyon about 5 miles southeast of Corona. Material from this quarry has been used on several small ocean projects constructed in 1965 and 1970. This quarry is currently in operation where other quarries in the Riverside-Corona area which had furnished suitable material in the past are no longer in operation.

XII - REAL ESTATE REQUIREMENTS

12.01 REQUIREMENTS. The Harbor Department will be required to: "Provide, without cost to the United States all lands, easements, and rights-of-way required for contractor mobilization, construction and subsequent maintenance of the project and for aids to navigation upon the request of the Chief of Engineers, including suitable areas determined by the Chief of Engineers to be required in the general public interest for initial and subsequent disposal of spoil, and also provide necessary retaining dikes, bulkheads, and embankments therefor or the costs of such retaining works."

12.02 RIGHT-OF-WAY DESCRIPTION. Three separate rights-of-way are required to accommodate three 27-inch ± pipelines and can be seen on plate 2. These pipelines are for the use of transporting the dredged material to the disposal site. The right-of-way widths vary from 10 feet ± between pavement and property lines within the rights-of-way of existing streets to 50 feet when crossing private property and railroad rights-of-ways. Where possible the pipelines will be laid on the ground but depressed under the streets, railroads, and driveways. The rights-of-ways will be acquired in the form of temporary easements for a period of 36 months, commencing February 1980. Most of the right-of-way is owned or controlled by the Harbor Department and a minimum of acquisition problems are anticipated.

a. The Reeves Field Route. This route serves the West Basin, East Basin and East Basin Channel. It has one common 5,000-foot line from the disposal area across Reeves Field, passes under the elevated part of the Vincent Thomas Bridge and is trenched under Seaside Boulevard, railroad tracks, and Ocean Avenue. At this location the line would branch in an easterly and western direction. The western branch would proceed westerly along the north side of Ocean Avenue across a container yard terminating near the fire boat station, a distance of 2,400 feet. The east branch would proceed easterly along Ocean Avenue; bore under two railroad tracks; trench under New Dock Street, a parking lot and Old Dock Street, terminating at Slip 215, a distance of 3,750 feet.

b. The Reservation Point Route. This route serves the southerly end of the Main Channel. It will be a submerged line commencing at a point near the NW corner of Reservation Point, proceed southerly along the west side of the point thence move easterly paralleling the south end of the Point to a point off the SE corner, and thence in a north and northeasterly direction to a point in the SW corner of the disposal area for a total distance of approximately 7,500 feet.

XIII - UTILITIES RELOCATION

13.01 GENERAL. This project element provides for the removal, relocation, or replacement of existing submarine pipelines and cables crossing harbor channels at elevations which would be in conflict with the dredging. These removals are necessary to provide an unobstructed clearance for the deepening project.

Various methods may be required to accomplish the removals. Lines with little or no cover can be pulled, cut into sections, and hauled away. Deeply buried lines must be uncovered by dredging. The dredged material will be disposed of in the landfill.

Relocated or replacement lines will be placed in dredged trenches with the top of the line no higher than elevation -55 feet MLLW within the channel and then backfilled with an approved clean material to an elevation not higher than -48 feet MLLW.

Removals and relocations are confined within the limits of the existing utility corridors as shown on plate 2 and described as follows with the exception of U.S. Coast Guard aids-to-navigation and relocations or removals required at the landfill site. A detailed description of the utilities to be relocated is contained in Appendix C, Removal and Relocation of Utilities.

13.02 DESCRIPTION OF UTILITIES. The following paragraphs describe the utilities to be removed or relocated.

a. Utility Corridor A.

(1) The Department of Water and Power has requested the Harbor Department to allow its line to remain in place, at its own risk. The existing 20 inch diameter water line is located at -45 feet MLLW, crossing from Berth 84 to 235. In the future, a new 30 inch diameter water line may be installed at -55 feet MLLW by the Department of Water and Power, approximately 600 feet southerly of its present location crossing from Berth 83 to Berth 236.

(2) The Department of Public Works and the Department of Public Utilities and Transportation intend to remove the existing 20 inch diameter abandoned sewer line housing communication cables at elevation -45 feet MLLW, crossing from Berth 84 to Berth 234.

b. Utility Corridor B.

(1) Western Union will remove an abandoned cable at elevation -45 feet MLLW, crossing from Berth 100 to Berth 150.

(2) Chevron U.S.A. will remove an abandoned 8 inch diameter oil pipeline at elevation -45 feet MLLW, crossing from Berth 98 to 150.

(3) Pacific Telephone will remove three cables at elevation -45 feet MLLW, crossing from Berth 100 to Berth 149.

c. Utility Corridor C.

(1) The Department of Public Utilities and Transportation and the Harbor Department will remove two 4 inch diameter and one 6 inch diameter abandoned oil pipelines, one with a communication cable at -40 feet MLLW, crossing from Berth 174 to Berth 218.

(2) Mobil Oil Company will remove six 6 inch diameter and one 8 inch diameter oil pipelines at elevation -40 feet MLLW, crossing from Berth 174 to 218. These lines will be replaced with one 10 inch diameter and one 16 inch diameter pipeline at elevation -57 feet MLLW adjacent to Mobil's existing right-of-way crossing from Berth 176 to Berth 216.

(3) Pacific Telephone will remove one cable at elevation -40 feet MLLW, crossing from Berth 174 to Berth 218.

(4) The Department of Public Works will remove one 16 inch diameter abandoned sewer line at elevation -40 feet MLLW, crossing from Berth 175 to Berth 218.

(5) The Department of Water and Power will remove one 12 inch diameter water line at elevation -40 feet MLLW, crossing from Berth 175 to Berth 218.

d. Terminal Island Treatment Plant Outfall Sewer. The Los Angeles City Bureau of Engineering is presently studying the feasibility of providing a temporary outfall for its 39 inch outfall sewer. The temporary outfall would serve for an interim period until permit requirements with EPA are determined or until further port dredging and landfill projects would again require its relocation. The existing outfall is proposed to be extended south of the new dike approximately 1,000 feet. This work will have to be completed before the dike installation at this location.

e. Sewer and Storm Drain Modifications - Terminal Island. Existing drains and industrial sewers presently discharging within the 190 acre area will be relocated or abandoned. The lines are listed below:

	Location	Owner	Description
(1)	Pier 301, east face	Harbor Dept.	18 inch storm drain
(2)	Pier 301, east face	Star-Kist	30 inch industrial sewer
(3)	Pier 301, east face	Harbor Dept.	42 inch industrial sewer
(4)	Pier 301, east face	Harbor Dept.	66 inch storm drain
(5)	Pier 301, east face	Harbor Dept.	42 inch storm drain

The disposition of each of these is presently being studied by the Port, Star-Kist, and Pan Pacific Fisheries. The first two storm drains listed, No. 1 and No. 4, will be rerouted with new outfalls located in Fish Harbor. The third storm drain, No. 5, will be rerouted with a

temporary outfall to the Reeves Field former seaplane anchorage area. A permanent drain will later be constructed after consolidation of the landfill. The industrial sewers, No. 2 and No. 3, may be abandoned or replaced to serve the two canneries based on revised handling of industrial waste treatment within each of their plants.

XIV - COST ESTIMATES

14.01 GENERAL. The costs associated with the deepening of the harbor consist of the Federal and non-Federal cost for dredging the channels and the cost to local interests for utility relocations and retention works for disposal of spoil. The costs have been figured for channels with depths ranging from the present depth to the maximum depth allowed by the structures along the harbor channels. The total first cost for the Los Angeles harbor deepening project as submitted in this design memorandum is estimated at $59,125,000, comprising a cost of $26,625,000 to the United States and $32,500,000 to local interest. The local interest cost excludes the cost of all self-liquidating items such as slips, structures, roads, etc., with the exception of the dikes to be located in the fill area.

14.02 COMPARISON OF PRESENT ESTIMATE OF FIRST COST WITH PREVIOUS ESTIMATES. A comparison of the present estimate of first costs with the previously approved estimate shown on the project cost estimate (PB-3) report and with the project document is given in the following table.

Estimated Costs

Item	Project Document (Jan. 75 PL)	Approved PB-3 Estimate (Oct. 78 PL)	Proposed Estimate (Oct. 79 PL)
Corps first costs			
Dredging	$8,845,000	$17,920,000	$25,600,000
Engineering and design	301,000	462,000	850,000
Supervision and Admin.	588,000	1,008,000	1,285,000
Subtotal	$9,734,000	$19,390,000	$27,735,000
Less local contribution			
for land enhancement	399,000	790,000	1,135,000
Aids-to-navigation			25,000
Total Fed. first costs	$9,335,000	18,600,000	$26,625,000
Non-Federal first cost			
Dikes	$12,813,000	$15,654,000	$13,000,000
Dredging	3,229,000	6,457,000	13,700,000
Utility relocation	1,000,000	2,499,000	4,665,000
Land enhancement			
contribution	399,000	790,000	1,135,000
TOTAL	$17,441,000	$25,400,000	$32,500,000
TOTAL PROJECT COSTS	$26,776,000	$44,000,000	$59,125,000

Annual Cost			
Federal	$ 582,000	$ 1,284,000	$ 1,840,000
Non-Federal	1,087,000	1,754,000	2,240,000
TOTAL	$1,669,000	$ 3,038,000	$ 4,080,000
Annual benefits			
Transportation saving	$13,340,000	$20,620,000	$12,030,000
Land enhancement	1,270,000	2,370,000	2,270,000
TOTAL	$14,610,000	$22,990,000	$14,300,000

The differences in costs between the project document estimate and the approved PB-3 estimate are explained in the following subparagraphs:

a. Dredging. The increase in cost is a result of a revised unit cost of dredging from $1.00 to $1.60 per cubic yard which amounts to $5,521,000 and price levels which amount to $3,554,000. The total increase is $9,075,000.

b. Engineering and Design. The cost increase for engineering and design is $161,000. Reanalysis of the requirements for the design memorandum, work required by U.S. Fish and Wildlife Service and increased real estate requirements account for an increase of $101,000. Price levels of $60,000 account for the remainder of the increase.

c. Supervision and Administration. The total increased cost for supervision and administration is $420,000. Reanalysis of the requirements for the design memorandum account for $217,000 and the remaining increase of $203,000 is due to price levels.

d. Non-Federal Costs.

(1) Dikes. An increase of $2,841,000 for the cost of dike construction results from price leveling of $3,130,000 and a redesign of the dikes which resulted in an estimated construction cost savings of $289,000.

(2) Dredging. The increased cost for dredging is $3,228,000. This increase is a result of increasing the unit cost of dredging from $1.00 to $1.60 per cubic yard which amounts to $1,937,000 and price levels which amount to $1,291,000.

(3) Utilities. The total increase for the relocation of the utilities amounts to $1,499,000. The Harbor Department increased their estimate by $1,000,000 and an increase of $499,000 is attributed to price levels.

(4) Land Enhancement. The increase for land enhancement of $391,000 is attributed to price levels.

The differences in costs between the approved PB-3 estimate and the present estimate are explained in the following subparagraphs:

a. Dredging. The increase in cost is due to an increase of 2,352,000 cubic yards of material to be dredged which amounts to $5,818,000, an increase of $788,000 for mobilization and demobilization a decrease in the contingency percentage from 15 to 12 percent which amounts to $532,000, and an increase of $1,606,000 for price leveling. The total increase amounts to $7,680,000.

b. Engineering and Design. An increase of $388,000 is due to increased engineering due to the endangered species, additional models studies, additional economic studies required, and additional cultural resource studies.

c. Supervision and Administration. An increase of $196,000 is due to the increased effort resulting from an expanded project and construction cost.

d. Aids-to-Navigation. Aids-to-navigation have not been taken into account until this cost estimate. They are estimated to cost $25,000 which is also an increase of that amount.

e. Non-Federal Costs.

(1) Dikes. A decrease of $2,654,000 for the cost of dike

construction is due to a reanalysis of the dike designs.

(2) Dredging. The increased cost for dredging is $7,243,000. An increase of 2,363,000 cubic yards in the volume to be dredged resulted in an increase of $6,144,000, - there was an increase of $518,000 for mobilization and demobilization, and an increase of $581,000 due to price leveling.

(3) Utilities. The increase in the relocation of utilities is due to a reanalysis of the construction costs and the material costs involved which is $1,941,000. An increase of $225,000 is due to price leveling. The total increase amounts to $2,166,000.

(4) Land Enhancement. The increase in the land enhancement is due to the increased cost of construction which amounts to $275,000 and $70,000 due to price leveling. The total increase amounts to $345,000.

f. Benefits. The benefits shown in the project document were priced leveled from the 1972 Interim Review Report as were the approved PB-3 benefits. The benefits for this report were determined utilizing the same as methodology, but used new corps vessel operating costs. There was apparently an over estimation of benefits by using straight index values in operating benefits from 1972 to 1978.

14.03 DETAILED ESTIMATE OF FIRST COST. The detailed estimate of first cost is based on October 1979 prive levels for similar work in the Los Angeles area. The detailed estimates of first costs for the construction of the general navigation improvements are contained in Appendix G, Cost Estimates, and are summarized in the following table.

DETAILED ESTIMATE OF FIRST COST
LOS ANGELES HARBOR DEEPENING PROJECT
(October 1979 Price Levels)

Cost Account No.	Item	Unit	Quantity	Unit Price	Amount
	CHANNEL IMPROVEMENTS FEDERAL COSTS Corps of Engineers				
09.	Mobilization and Demobilization	L.S.			$ 1,386,000
	Dredging				
	Unconsolidated Sediments	Cu. Yd.	8,229,000	$1.95	16,047,000
	Bedrock	Cu. Yd.	1,494,000	3.65	5,453,000
	Contingencies (12 percent)				2,714,000
	Subtotal				$25,600,000
30.	Engineering and Design				
	Design Memorandum				690,000
	Plans and Specifications				50,000
	Engineering During Construction				110,000
	Subtotal				$ 850,000

31.	Supervision and Administration				1,285,000
	TOTAL				$27,735,000
	Less Local Contribution (4.1 percent of cost of general navigation features)				1,135,000
	Total Corps of Engineer's Cost				$26,600,000
02.3	U.S. Coast Guard				
	Aids-to-Navigation	L.S.			25,000
	Total Federal First Cost				$26,625,000
	NON-FEDERAL COSTS				
	Mobilization and Demobilization				$ 714,000
	Dredging				
	Unconsolidated sediments	Cu. Yd.	3,926,000	$ 1.95	7,656,000
	Bedrock	Cu. Yd.	1,058,000	3.65	3,862,000
	Contingencies (12 percent)				1,468,000
	Retaining Dike				
	A5 Stone	Ton	190,000	21.78	4,138,000
	A.5 Stone	Ton	39,000	19.36	755,000
	B.5 Stone	Ton	78,000	19.36	1,510,000
	C Stone	Ton	547,000	9.52	5,207,000
	Contingencies (12 percent)				$ 1,390,000
	Subtotal				$26,700,000

Utility Removal and Relocation*	4,665,000
Cash Contribution	1,135,000
Total Non-Federal First Cost	$32,500,000
TOTAL PROJECT COST	$59,125,000

* Includes engineering and design, mobilization and demobilization.

XV - SCHEDULE FOR DESIGN AND CONSTRUCTION

15.01 GENERAL. The final plans and specifications are scheduled to be approved by January 1980. Construction funds have been made available to initiate construction since the beginning of fiscal year 1979; however, construction has not started due to environmental considerations with respect to the disposal of the dredged material. Allotment of Federal funds, escalated to the midpoint of construction, would be required for the Corps of Engineers as follows:

Fiscal Year	Funds Required	Funds Budgeted
1979		$500,000
1980	$ 4,900,000	4,000,000
1981	14,500,000	
1982	10,000,000	
TOTAL	$29,400,000	

15.02 CONSTRUCTION.

The plan for building the dikes and dredging the harbor requires coordination between the rock work and dredging. The mobilization of the dredges can take two to three months whereas the rock work could start within a month of contract award. While the dredges are being mobilized, the first lift of rock work on the south dike would be initiated. The first lift would be nearing completion when the dredges

would be available to start dredging. The first dredging episode would be where the silty sand and sandy silt is located. This material could be placed in the first lift behind the rock dike which extends to -5 feet MLLW. The material will be used as a base for the second lift and as a filter between the more polluted material and the dike face. This episode would take three weeks to complete. The second dredge would initiate dredging in the bedrock area. The spoil would initially be disposed of in the northwest corner of the landfill. This episode would take about 13 months and fill the landfill an average of eight feet deep. The dike work would continue by placing the second lift of quarry run underlayer and armor stone to +10-foot elevation.

The armor stone should follow closely behind the second quarry run lift. The time to complete this second lift, underlayer and armor would be about six months. The breakwater would take an additional three months to complete.

The first dredge, after completing the first sand lift on the south dike, would divert to dredging the inner harbor material. The sand in the outer harbor must be conserved for the shallower water habitat and for sealing the dikes. The course material in the inner harbor should go into the first lift of the east dike to provide a firm foundation. This should take about a month and can be done anytime before the rock is placed on the east dike. The east dike can be constructed after the south dike is completed to elevation

+10 MLLW and the breakwater is completed. The east dike should then be constructed within three months, and completed within 16 months from contract award. The bedrock dredging, including the Harbor Department clean-up work should fill the first landfill lift eight-feet deep. The sand in the outer harbor should be used in the fill behind the east and south dikes. This operation should take about two months. The rock-dike work will require an additional month to complete to bring the elevation of the south dike to +17 feet MLLW. After 16 months from start of construction, the rock dike should be completed.

The remaining work items are to dredge the inner harbor and the remainder of the outer harbor and construct the shallower water habitat. The outer harbor dredging can proceed during the summer months when low wave activity should present the least problems to the dredge. At the end of 16 months, 6,656,000 cubic yards of soft material remains to be dredged. This must be done within 14 months to meet a 30 month schedule. The dredge with the booster can pump 5,824,000 cubic yards in this time. This leaves 832,000 cubic yards that can be pumped by the second dredge. The second dredge could accomplish this within three months, but would be confined to shorter pumping distances with lower production unless a booster is used. This dredge could then be released or used to aid the first dredge to complete the job in less than 30 months.

XVI - OPERATION AND MAINTENANCE

16.01 RESPONSIBILITY. Maintenance of the aids-to-navigation and all water areas and depths within the project limits would be a Federal civil-works responsibility. Maintenance outside of the project limits would be the responsibility of local interests.

16.02 MAINTENANCE. The harbor channels have experienced an insignificant amount of shoaling since their initial dredging over fifty years ago. Based on this performance no maintenance of the project dimensions is anticipated.

XVII - APPORTIONMENT OF COSTS

17.01 As considered herein, project costs include only those items that would not be self-liquidating. Self-liquidating items are to be provided by local interests and include wharfs, transit sheds, and other allied terminal installations.

Under the project document, monetary benefits from channel improvements were determined to be 4.1 percent local, and 95.9 percent general in nature. Thus, pursuant to general policy, the Federal Government would bear 95.9 percent of the cost of the proposed channel improvement, excluding the pre-authorization studies and aids-to-navigation. Local interests would contribute 4.1 percent of the cost of dredging the project channels.

Local benefits accrue from land enhancement to the areas that are owned by the Harbor Department. The project-document provided that material dredged from the channel was to be deposited in a submerged area south of Terminal Island. It was estimated that 190 acres would be enhanced with an average annual equivalent benefit to local interests of $2,270,000.

As covered in the project-document, furnishing the dikes, bulkheads, and embankments for the landfill is responsibility of local interests.

The Harbor Department has requested that the construction of the dikes and relocation of the utilities be included and accomplished under the channel dredging contract. They propose to advance sufficient funds to accomplish this work at the time they make their cash contribution for the first cost of the dredging. A separate bid item will be provided in the construction contract so that the cost for these items can be determined. At the conclusion of the construction contract, any unused money furnished by the Harbor Department for this work will be returned.

XVIII - STATEMENT OF FINDINGS

18.01 The District Engineer finds as follows:

a. The principal elements of the project are the deepening and widening of existing waterways for access to terminals and the placement of the dredged materials in a diked fill on the south side of Terminal Island.

b. An environmental impact statement has been compiled which: (a) covers all known environmental impacts; (b) examined the socio-economic impacts of the proposed project; (c) considered the project effects on the surrounding community; (d) reviewed engineering plans for the project; and (e) suggested alternatives. The findings and comments of all interested parties have been reviewed and the possible alternatives considered.

c. In the evaluation the following points were considered:

(1) Engineering Considerations. The recommended project has been designed to accomplish its purposes with as little resulting noise, air and water pollution as possible. Detailed analysis indicates that the dredging of the existing waterways to a depth of 45 feet MLLW is necessary to accommodate large vessels currently in use and anticipated to be built in the near future. This depth can be obtained without affecting

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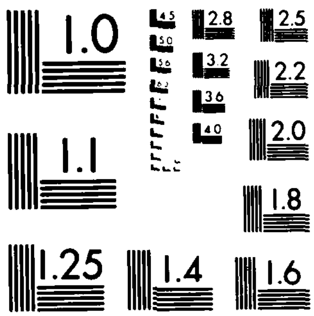

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existing structures along the channels other than utilities, which would be relocated by local interests. Alternative solutions involving lightering or diversion of cargoes to other ports would be prohibitively expensive. Alternative solutions involving construction of channels to depths less than 45 feet MLLW do not provide the requisite facilities needed to handle the anticipated vessel traffic. Alternative methods of disposal of the dredged materials out to sea would increase the overall project costs. There would be no difference in the comparative effects of these alternative methods and the recommended plan on the Federal operation and maintenance of the project.

(2) Economic Considerations. The Port of Los Angeles, the immediate tributary area, and extensive hinterlands will benefit substantially from increased trade as the result of the project's completion. The planned disposal method is consistent with plans of the local sponsor. The recommended plan does provide for the maxmimum net benefits and yields the greatest benefit-to-cost ratio. The recommended plan provides for the most feasible project to serve the immediate needs and recognizes that prior to 2000, the project should be reevaluated in terms of changed social, economic, and environmental conditions to determine the justification for deeper channels.

(3) Social well being considerations. The citizenry of the port will benefit from wages and taxes generated by the project and by

the resulting increase in trade. The proposed project will have significant short and long-term beneficial effects on net national and regional economic development by reducing shipping transportation costs, increasing employment, income and revenues and improving the balance of payments. It is expected that no significant adverse social or economic effects will result from the project.

(4) Environmental Considerations. The recommended project will permanently alter bottom habitats in the areas that will be dredged; and will eliminate harbor bottom habitats and open water in the area used for disposal. The project will have an insignificant effect on tidal circulation in the harbor. There will be temporary turbidity in the areas of dredging or dredge spoil disposal. Pollutants associated with the dredged material will not be introduced into marine waters. Minor amounts of pollutants are expected to be dispersed into the harbor waters as a result of dredging, but most of the bottom sediments with pollutants dredged from the harbor will be disposed in the landfill, thus permanently removing them from the marine ecosystem. Possible adverse environmental impacts will be short-lived and are outweighed by economic and social benefits. Alternatives involving lightering or diversion of cargoes to other ports would leave present environmental conditions unchanged in the immediate area although, as noted, the opportunity to upgrade the quality of the substrate by removal of pollutants from the harbor would be foregone. In addition, if cargoes were diverted to other ports there would be, as also noted previously, environ-

mentally undesirable effects due to increased land transportation requirements to bring the diverted cargoes into the Los Angeles area and its hinterland. Alternative solutions involving construction of depths less than recommended or deepening of only a portion of the channels and basins have similar impacts to those of the recommended plan, which, of course, are generally proportional to their comparative extent.

d. The desired purpose of the project can best be obtained by the recommended plan. Alternatives have been considered involving the method of spoil deposition. Each has been found less satisfactory than the recommended plan. The environmental impacts of the recommended plan for the proposed project were small and were offset by beneficial impacts made by the proposed project. The project is feasible, and as formulated would minimize environmental damage.

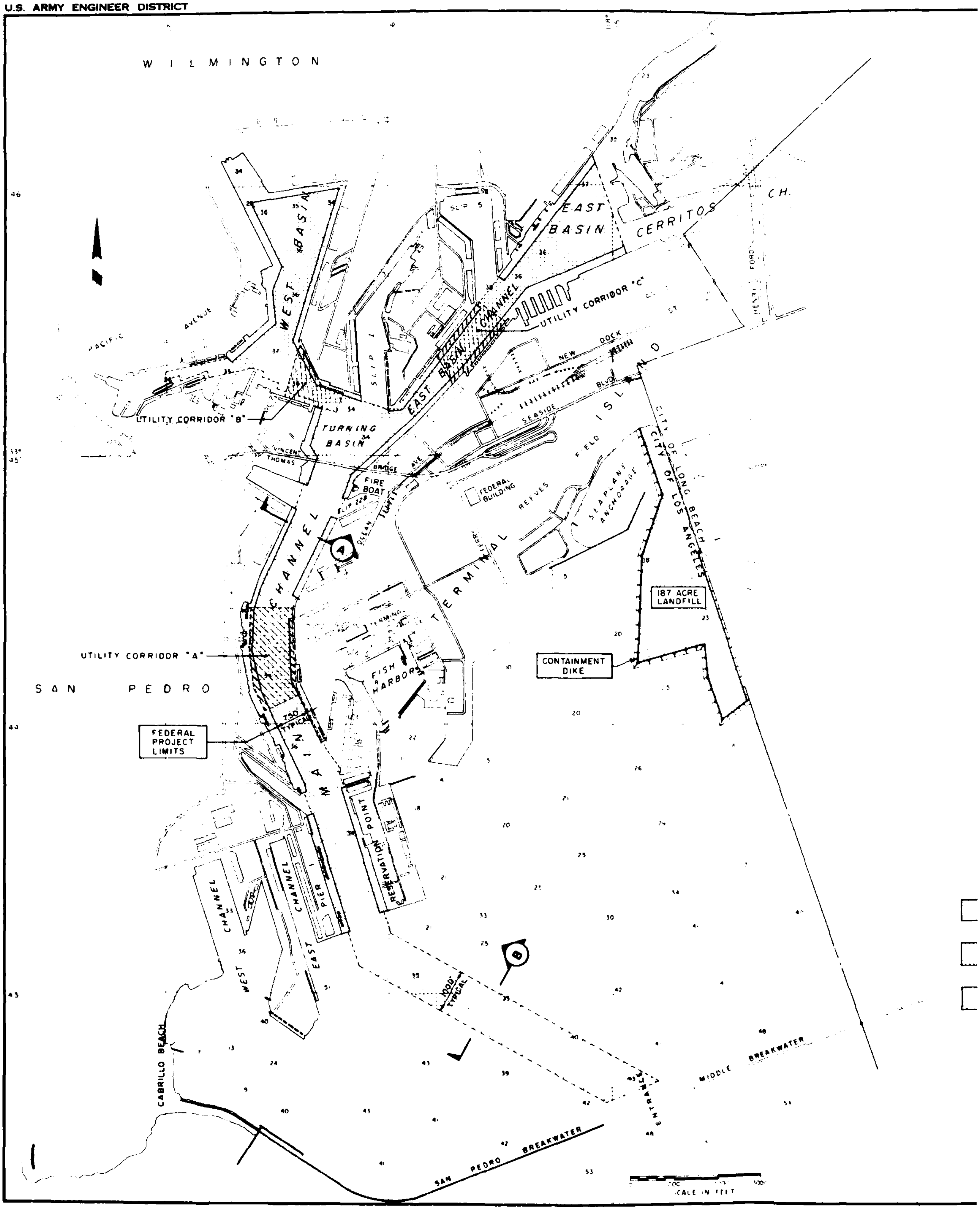
XIX - CONCLUSIONS AND RECOMMENDATIONS

19.01 CONCLUSIONS. The Los Angeles harbor deepening project is well justified. It would provide deeper channels to serve larger vessels carrying both the cargo flowing through the harbor today and the future potential tonnage which can be expected to flow through the harbor. The benefit-cost ratio for the entire project is 3.5 to 1. It is considered in the overall national, regional, and local interests that the project be constructed as presently recommended.

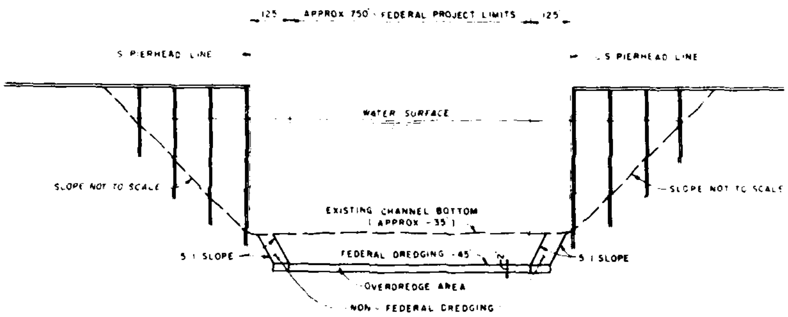
19.02 RECOMMENDATIONS. The district engineer recommends that the project described in this general design memorandum and as shown on plate 2 be approved as the basis for preparation of plans and specifications for construction of the project.

Gwynn A. Teague
Gwynn A. Teague
COL, CE
District Engineer

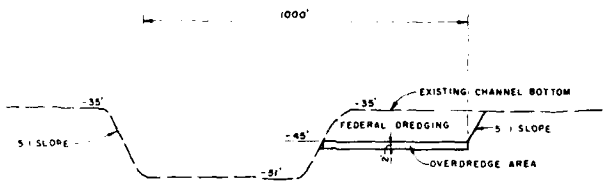
U.S. ARMY ENGINEER DISTRICT



CORPS OF ENGINEERS



MAIN CHANNEL SECTION (A)



ENTRANCE CHANNEL SECTION (B)

TYPICAL DREDGING SECTIONS

VERTICAL SCALE IN FEET

HORIZONTAL SCALE IN FEET

LEGEND

☐	NON - FEDERAL DREDGING TO -45'
☐	FEDERAL DREDGING TO -45'
☐	LANDFILL

NOTES

1. VERTICAL DATUM MEAN LOWER LOW WATER
2. BASE MAP PREPARED FROM NOAA CHART NO 18751, MARCH 1978

SYMBOL	DESCRIPTIONS	DATE	APPROVAL

REVISIONS

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY:

DRAWN BY:

CHECKED BY:

LOS ANGELES - LONG BEACH HARBORS, CALIFORNIA
LOS ANGELES, CALIFORNIA

LOS ANGELES HARBOR DEEPENING PROJECT

AUTHORIZED PLAN

SUBMITTED BY:

APPROVED:

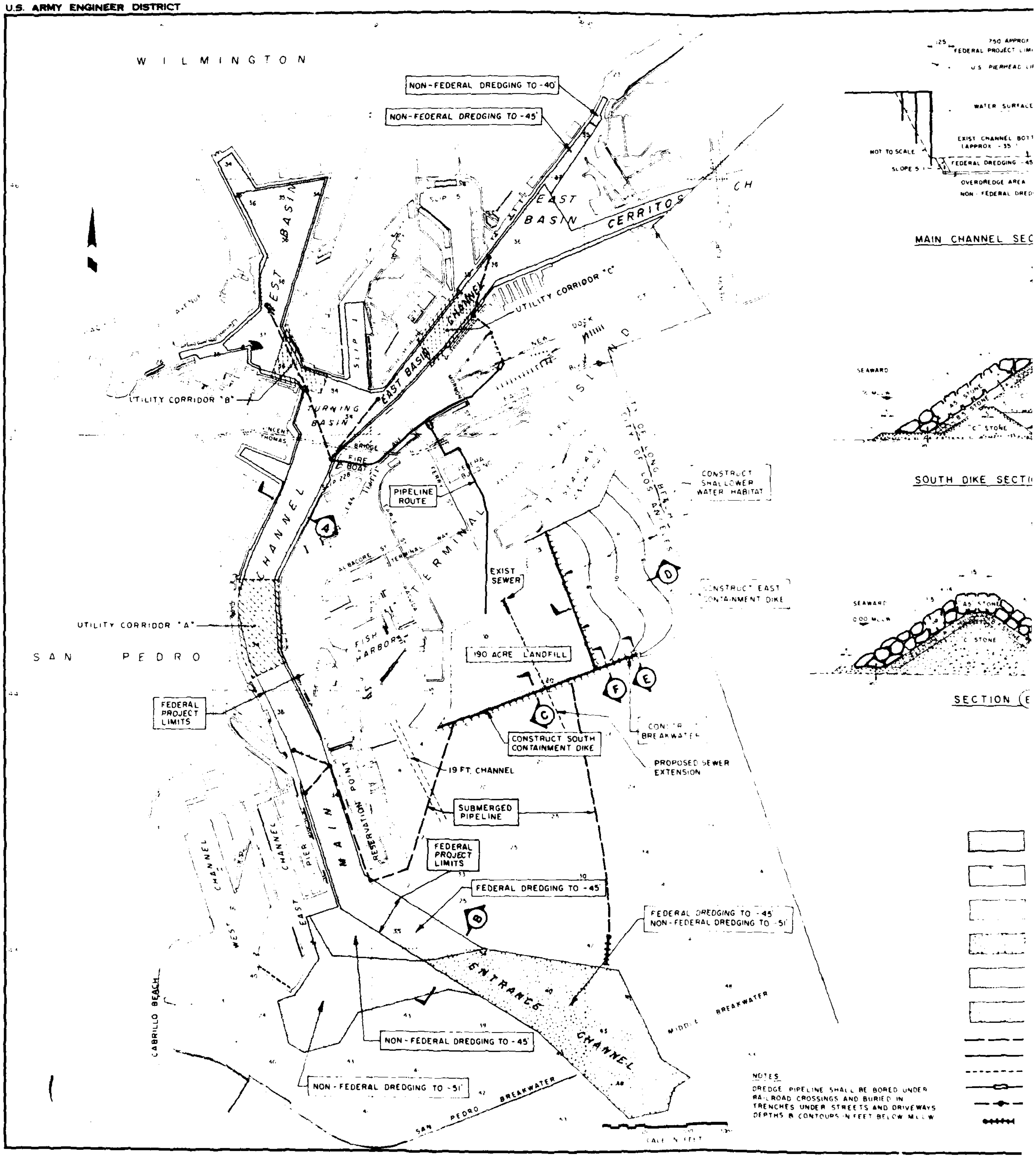
APPROVAL RECOMMENDED

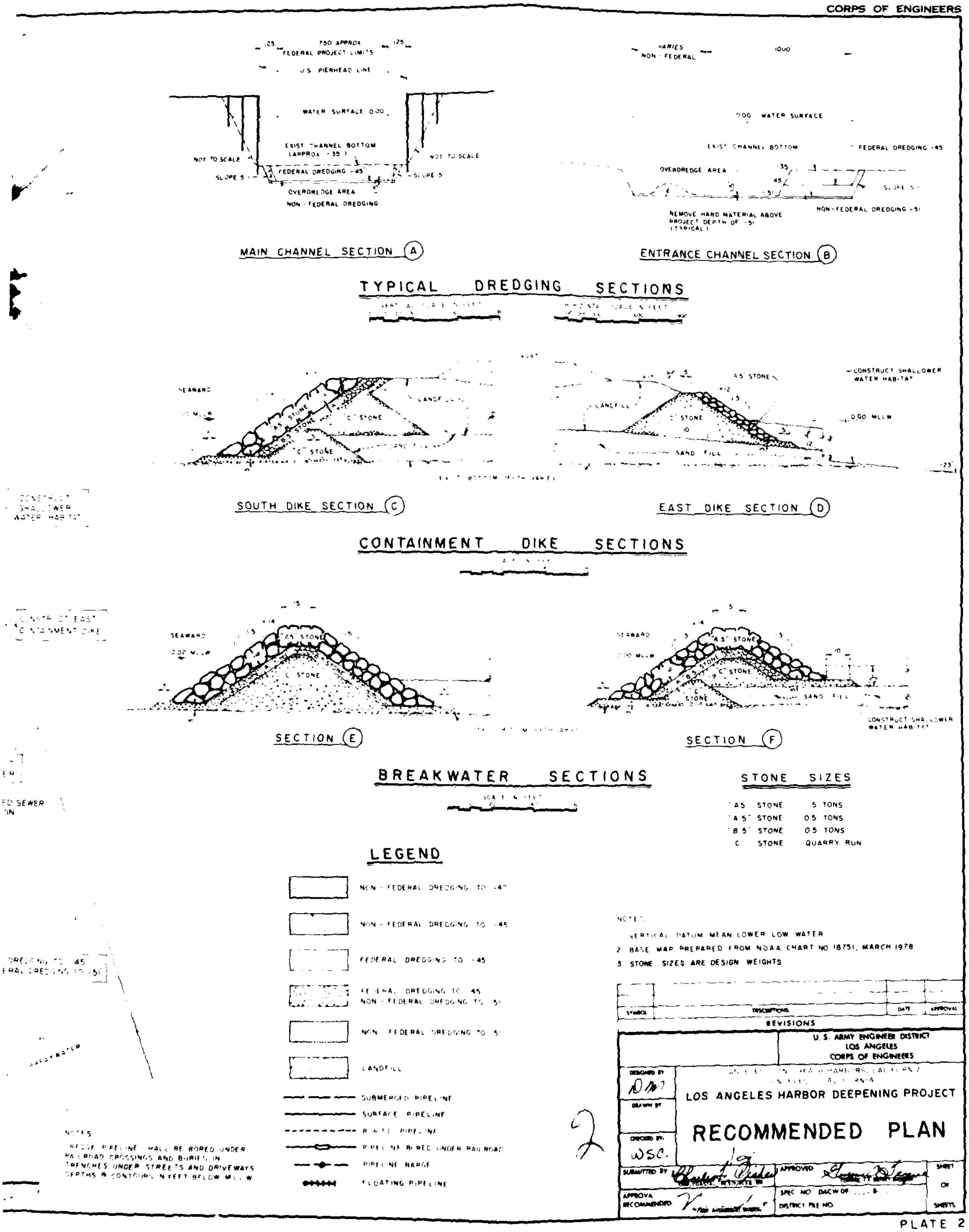
SPEC. NO. DACW 09-

DISTRICT FILE NO.

SHEET OF SHEETS

U.S. ARMY ENGINEER DISTRICT





CORPS OF ENGINEERS
750 APPROX
FEDERAL PROJECT LIMITS
U.S. PIERHEAD LINE
WATER SURFACE 0.00
EXIST. CHANNEL BOTTOM (APPROX. -35)
NOT TO SCALE
FEDERAL DREDGING -45
OVERDREDGE AREA
NON-FEDERAL DREDGING
MAIN CHANNEL SECTION (A)
VARIES
NON-FEDERAL
1000
0.00 WATER SURFACE
EXIST. CHANNEL BOTTOM
FEDERAL DREDGING -45
OVERDREDGE AREA
NON-FEDERAL DREDGING -51
REMOVE HARD MATERIAL ABOVE PROJECT DEPTH OF -51 (TYPICAL)
ENTRANCE CHANNEL SECTION (B)
TYPICAL DREDGING SECTIONS
SEAWARD
"A5" STONE
"B5" STONE
"C" STONE
LANDFILL
CONSTRUCT SHALLOWER WATER HABITAT
0.00 MLLW
SAND FILL
SOUTH DIKE SECTION (C)
EAST DIKE SECTION (D)
CONTAINMENT DIKE SECTIONS
SEAWARD
0.00 MLLW
"A5" STONE
"C" STONE
SECTION (E)
"A5" STONE
"B5" STONE
"C" STONE
SAND FILL
CONSTRUCT SHALLOWER WATER HABITAT
SECTION (F)
BREAKWATER SECTIONS
STONE SIZES
"A5" STONE 5 TONS
"A.5" STONE 0.5 TONS
"B.5" STONE 0.5 TONS
"C" STONE QUARRY RUN
LEGEND
NON-FEDERAL DREDGING TO -45
FEDERAL DREDGING TO -45
FEDERAL DREDGING TO -45 NON-FEDERAL DREDGING TO -51
NON-FEDERAL DREDGING TO -51
LANDFILL
SUBMERGED PIPELINE
SURFACE PIPELINE
BURIED PIPELINE
PIPELINE BORED UNDER RAILROAD
PIPELINE BARGE
FLOATING PIPELINE
NOTES
VERTICAL DATUM MEAN LOWER LOW WATER
2 BASE MAP PREPARED FROM NOAA CHART NO 18751, MARCH 1978
3 STONE SIZES ARE DESIGN WEIGHTS
REVISIONS
SYMBOL
DESCRIPTIONS
DATE
APPROVAL
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS
LOS ANGELES HARBOR DEEPENING PROJECT
RECOMMENDED PLAN
DESIGNED BY
DRAWN BY
CHECKED BY
SUBMITTED BY
APPROVED
APPROVAL RECOMMENDED
SPEC NO DACW09
DISTRICT FILE NO
SHEET
OF
SHEETS

PLATE 2

APPENDICES

APPENDIX A

LOCAL COOPERATION

CONTENTS

JACK L. WELLS
GENERAL MANAGER

MAIL ADDRESS
P. O. Box 151
SAN PEDRO, CALIFORNIA 90733

CABLE ADDRESS
LAPORT

(213) 548-7801

PORT OF LOS ANGELES

CITY OF LOS ANGELES
TOM BRADLEY
MAYOR

January 9, 1979

Colonel Gwynn A. Teague
District Engineer
Dept. of the Army
L.A. District Corps
of Engineers
P. O. Box 2711
Los Angeles, CA 90053

Dear Colonel Teague:

SUBJECT: LOS ANGELES DEEPENING PROJECT - LOCAL CONDITIONS OF COOPERATION

At the meeting of the Board of Harbor Commissioners held on Wednesday, January 3, 1979, your communication dated December 5, 1978, transmitting a form of the draft agreement between the United States of America and the Harbor Department for the Los Angeles deepening project was presented and ordered filed following the adoption of Resolution No. 4322 which reaffirms the City's desire to proceed with the deepening project and to abide by necessary conditions of local cooperation.

As directed by the Board of Harbor Commissioners, I am forwarding to you a certified copy of Resolution No. 4322 which has been entered in the minutes of the proceedings of the Los Angeles Board of Harbor Commissioners.

Very truly yours,

Tsuyoko Ota

Tsuyoko Ota
Secretary

TO:ay
Encs.

RESOLUTION NO. 4322

WHEREAS, resolutions of the Senate Committee on Public Works adopted July 28, 1956, and May 11, 1967, authorized a review of all reports on the Los Angeles and Long Beach harbors for the purpose of determining the advisability of modifying the existing project in any way; and

WHEREAS, in its Second Session, the 94th Congress of the United States passed the Water Resources Development and River Basin Monetary Act of 1976 (House Doc. 94-594), authorizing a dredging project for the deepening of inner channels and basins and the main and entrance channels of the Port of Los Angeles to forty-five (45) feet, said Act being signed by the President on October 23, 1976; and

WHEREAS, it is the policy of the United States to undertake the improvements of a deep-draft harbor only in cooperation with a properly constituted public body having authority to contribute financially to the project and to operate essential facilities; and

WHEREAS, the District Engineer, United States Army Corps of Engineers and the Chief of Engineers have concluded that the aforementioned dredging project, if undertaken with Federal funds, should be subject to specific conditions of local cooperation hereinafter named; and

WHEREAS, the District Engineer, United States Army Corps of Engineers, has requested by letter dated December 5, 1978, that the Harbor Department reaffirm its willingness to provide the necessary local assurances;

NOW, THEREFORE, BE IT RESOLVED by the Board of Harbor Commissioners of the City of Los Angeles, that as required by the Congress of the United States, it is its intent to assist the Federal Government in undertaking the aforementioned navigation improvement. Such assistance may include assuming, to the best of its ability, certain obligations to be described in a contract to be prepared in accordance with Section 221 of the Flood Control Act of 1970. Said obligations may generally require the Harbor Department of the City of Los Angeles to:

(1) Provide without cost to the United States all lands, easements, and rights-of-way required for contractor mobilization, construction and subsequent maintenance of the Project and for related aids-to-navigation, including suitable areas for initial and subsequent disposal of spoil, and the necessary retaining dikes, bulkheads, and embankments therefor, or the costs of such works;

(2) Subject to Section 9, Public Law 93-251, hold and save the United States free from damages that may result from the construction of the project, excluding damages due to the fault or negligence of the United States or its contractors;

(3) Provide and maintain without expense to the United States adequate public terminal and transfer facilities;

(4) Provide and maintain without cost to the United States depths in berthing areas and local access channels

serving those terminals which may reasonably utilize the depth provided in the related project areas;

(5) Accomplish without cost to the United States such alternations in sewer, water supply, drainage, and other utility facilities, as may be required by reason of the dredging project;

(6) Contribute 4.1 percent of the Federal first cost of the dredging project; this contribution is presently estimated at $790,000; such contribution to be made in a lump sum prior to start of construction;

(7) If necessary, establish regulations concerning discharge of pollutants in the waters of the harbor by users thereof, which regulations shall be in accordance with applicable laws or requirements of Federal, State and local authorities responsible for pollution prevention and control;

(8) Prohibit erection of any structure within 125 feet of project channels and basins;

(9) Comply with the requirements of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646, 84, Stat. 1894, approved January 2, 1971); and

(10) Provide the Government the right to enter upon, at reasonable times and in a reasonable manner, lands which the Department owns or controls for access to the project for the purpose of inspection.

BE IT FURTHER RESOLVED that both the representatives of the United States Army Corps of Engineers and the Board of Harbor Commissioners recognize:

(1) That the California Environmental Quality Act of 1970 requires the preparation and consideration of an environmental impact report prior to the time the Board takes an action which commits the City of Los Angeles to a definite course of conduct on a project such as is described in this resolution;

(2) That prior to the commencement of work on the project, the Board, on behalf of the City of Los Angeles, will be requested by the United States to enter into a legally binding contract incorporating, with or without modification, some or all of the ten assurances set forth hereinabove;

(3) That prior to making its decision as to whether to authorize the execution of such contract, the Board will consider the environmental impact report and all other relevant information; and

(4) That the "assurances" above may require approval by the Council of the City of Los Angeles in addition to approval by the Board.

BE IT FURTHER RESOLVED that:

(1) The Board receive and file Colonel Teague's December 5, 1978, cover letter and accompanying draft Agreement directed to Commissioner Nate DiBiasi on behalf of the Board;

(2) This resolution be entered in the minutes of the proceedings of the Board of Harbor Commissioners of the City of Los Angeles; and

(3) The Secretary is hereby directed to forward a certified copy of this resolution to the District Engineer, Attention of Colonel Gwynn A. Teague, United States Army Engineer District, Los Angeles Corps of Engineers, 300 North Los Angeles Street, Los Angeles, California 90012.

I HEREBY CERTIFY that the foregoing Resolution was adopted by the Board of Harbor Commissioners of the City of Los Angeles at its meeting held

JAN [illegible]

Secretary

APPROVED AS TO FORM

12/29, 1978

BURT PINES, City Attorney

By

RAYMOND P. BENDER, Deputy

RPB:jm:ls
12/29/78

DRAFT
AGREEMENT BETWEEN
THE UNITED STATES OF AMERICA
AND
THE HARBOR DEPARTMENT, CITY OF LOS ANGELES

THIS AGREEMENT, entered into this __ day of _____________ 19__ by and between the UNITED STATES OF AMERICA (hereinafter called the "Government"), represented by the Contracting Officer executing this Agreement, and the City of Los Angeles, through THE HARBOR DEPARTMENT, CITY OF LOS ANGELES (hereinafter called the "Department").

WITNESSETH THAT:

WHEREAS, construction of a channel improvement known as the Los Angeles-Long Beach Harbors, California, Los Angeles County, California (hereinafter called the "Project"), was authorized by Water Resources Development Act of 1976, Public Law 94-587, Approved October 22, 1976; and

WHEREAS, the Department hereby represents that it has the authority and capability to furnish the non-Federal cooperation required by the Federal legislation authorizing the Project and by other applicable law; and

WHEREAS, the Department is empowered to enter into this agreement by reason of the authority of: Article XI of the Los Angeles City Charter

NOW, THEREFORE, the parties agree as follows:

1. The Department agrees that, if the Government shall commence construction of the project in the Los Angeles County, California, substantially in accordance with Federal legislation authorizing such Project (Public Law 94-587), the Department shall, in consideration of the Government commencing construction of such Project, fulfill the requirements of non-Federal cooperation specified in such legislation, to wit:

a. Provide, without cost to the United States, all lands, easements, and rights-of-way required for construction and subsequent maintenance of the Project and for aids to navigation upon the request of the Chief of Engineers, including suitable areas determined by the Chief of Engineers to be required in the general public interest for

initial and subsequent disposal of dredged material, and also provide necessary retaining dikes, bulkheads, and embankments therefor or the costs of such retaining works;

b. Subject to Section 9, Public Law 93-251, hold and save the United States free from damages that may result from the construction and maintenance of the project;

c. Provide and maintain at local expense adequate public terminal and transfer facilities open to all on equal terms;

d. Provide and maintain without cost to the United States depths in berthing areas and local access channels serving the terminals commensurate with the depths provided in the related project areas;

e. Accomplish without cost to the United States such alterations as may be required in sewer, water supply, drainage and other utility facilities;

f. Contribute in cash 4.1 percent of the Federal first cost of dredging the project channels, presently estimated at $1,135,000. Such contribution to be made in a lump sum prior to construction;

g. Establish regulations concerning discharge of pollutants into the waters of the harbor by users thereof, which regulations shall be in accordance with applicable laws or requirements of Federal, State, and local authorities responsible for pollution prevention and control;

h. Prohibit erection of any structure within 125 feet of project channels and basins.

2. The Department hereby agrees that it will comply with the requirements of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646, 84, Stat. 1894, Approved 2 January 1971).

3. The Department gives the Government the right to enter upon, at reasonable times and in a reasonable manner, lands which the Department owns or controls for access to the Project for the purpose of inspection.

4. This agreement is subject to the approval of the Secretary of the Army.

IN WITNESS, WHEREOF, the parties hereto have executed this contract as of the day and year first above written.

HARBOR DEPARTMENT
CITY OF LOS ANGELES

By
President
Board of Commissioners

THE UNITED STATES OF AMERICA

By
District Engineer
Contracting Officer

DATE:

APPROVED:

Secretary of the Army

ATTEST:

By
Secretary, Board of Commissioners

The Undersigned, as Counsel for the Harbor Department, City of Los Angeles, having considered the effect of Section 221 of Public Law 91-611, approves the foregoing Agreement as to form and legality this __ day of ________________ 19__.

Counsel
Harbor Department
City of Los Angeles

APPENDIX B

PERTINENT CORRESPONDENCE

CONTENTS

Section 7 CONSULTATION

Corps	10 January 1978
FWS	23 March 1978
Corps	26 July 1978
FWS	27 September 1978
Corps	22 November 1978
FWS	6 December 1978
FWS	3 April 1979
Corps	15 May 1979

GLENN M. ANDERSON
32D DISTRICT, CALIFORNIA

2410 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, D.C. 20515
TELEPHONE: (202) 225-6676

300 LONG BEACH BOULEVARD
(P.O. BOX 2349)
LONG BEACH, CALIFORNIA 90891
TELEPHONE: (213) 548-2721

Congress of the United States
House of Representatives
Washington, D.C. 20515

COMMITTEES:
PUBLIC WORKS AND TRANSPORTATION
- CHAIRMAN, AVIATION SUBCOMMITTEE
- MEMBER, SURFACE TRANSPORTATION SUBCOMMITTEE
- MEMBER, WATER RESOURCES SUBCOMMITTEE

MERCHANT MARINE AND FISHERIES
- MEMBER, FISHERIES AND WILDLIFE CONSERVATION AND THE ENVIRONMENT SUBCOMMITTEE
- MEMBER, MERCHANT MARINE SUBCOMMITTEE
- MEMBER, OCEANOGRAPHY SUBCOMMITTEE

- MEMBER, NATIONAL TRANSPORTATION POLICY STUDY COMMISSION

December 19, 1977

Hugh C. Robinson, Colonel, CE
District Engineer
Department of the Army
Los Angeles District, Corps of Engineers
P.O. Box 2711
Los Angeles, California 90053

Dear Colonel Robinson:

I am happy that it was possible for me to attend the Public meeting on December 12, 1977.

Enclosed, for your record, is a copy of my statment at that meeting.

It would be appreciated if you would continue to inform me of new information regarding the progress of the Los Angeles Harbor improvement project.

Sincerely,

Glenn

Glenn M. Anderson, M.C.

GMA/lrd

Enclosure

REMARKS OF CONGRESSMAN GLENN M. ANDERSON

December 14, 1977

Colonel Robinson, Fred Crawford, Assemblyman Vincent Thomas; friends----

I wish to take this opportunity to reiterate my strong support for the channel deepening project in Los Angeles Harbor. Perhaps you are aware that I was actively involved in obtaining the approval of this project in the Congress. The authorizing legislation providing the $16 million dollars for deepening the channel was my Legislation---The measure creating the Model Study at Vicksburg, Mississippi was also mine. I mention these merely to indicate my deep interest in this issue that we are discussing here tonight.

It is vitally important that the authorized project depth of 45 feet be achieved as expeditiously as possible.

As you know the tonnage passing through Los Angeles Harbor will almost double by 1990. Today less than 50% of the Containerized vessels can get into the Port of Los Angeles---thus forcing them to go to Oakland or elsewhere. The ports of this area raise about $450 million dollars annually in customs alone for the Federal Treasury.

Thus, it is apparent how important this channel deepening is from the point of view of commerce and trade on the federal level---to jobs and economic activity on the local level. The increased depths we're proposing will allow the most modern containers and bulk carriers to perform this essential function with fewer ships per ton.

Thus, it is hoped that the expanded cargo load can be carried with approximately the same number of ships entering the Los Angeles Harbor now.

This is vital to an improved environment and a safety conscious public.

While I am avid in my support for this project, I at the SAME time realize the need for recreational boating facilities. That is--- an adequate number of slips for our recreational boating. I am hopeful that a balanced approach will insure that these recreational needs are provided within the Port of Los Angeles.

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

MAILING ADDRESS
COMMANDER (oan)
ELEVENTH COAST GUARD DISTRICT
UNION BANK BLDG.
400 OCEANGATE
LONG BEACH, CA. 90822

16514/PF
Ser: oan 333-78
OCT 10 1978

From: Commander, Eleventh Coast Guard District
To: District Engineer, U. S. Army Corps of Engineers, Los Angeles District

Subj: Dredging of Los Angeles Channel; aids to navigation changes

Ref: (a) Your letter SPLED-C.W. dated 1 September 1978
(b) CCGDELEVEN letter 16514/PF Ser: oan 255-78 dated 28 July 1978

1. The additional areas to be dredged, as provided in reference (a) will require further changes of aids to navigation than those provided in reference (b).

2. As requested, the following changes of aids to navigation will be required:

a. Relocate Los Angeles Main Channel Range Front Light (LL 426) and Rear Light (LL 427).

b. Relocate Los Angeles Channel Light 5 (LL 430).

c. Relocate Los Angeles Channel Light 6 (LL 431).

3. Revised cost estimate for the rebuilding of these structures is $35,000. It is requested that the removal of the wood pile structures for Los Angeles Channel Lights 5 and 6 be included in the dredging project.

4. In the interest of navigational safety, it is recommended that the two areas indicated below and pictured on the enclosed chartlet be included in the project to be dredged to channel depth.

#1		#2	
33-42-37N 118-14-42.5W	(Along East edge of new channel)	33-42-32.5N 118-14-57.1W	(Along West edge of present Channel)

16514/PF
Ser: oan 333-78
OCT 10 1978

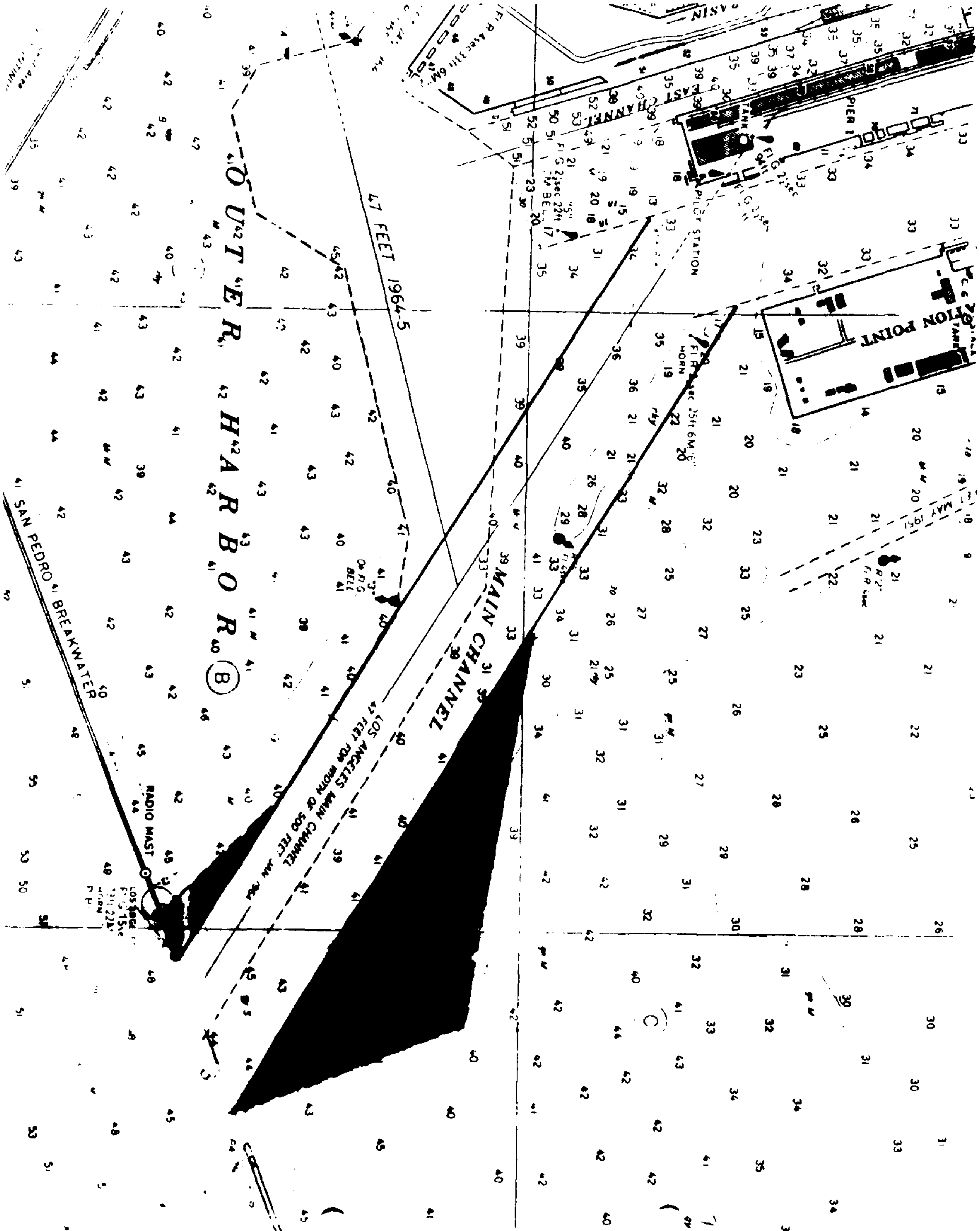
Subj: Dredging of Los Angeles Channel; aids to navigation changes

33-43-01N 118-15-29.2W	(Along east of new channel)	33-42-40N 118-15-12.1W	(Along West edge of present channel)
33-42-55.5N 118-14-51W		33-42-30.9N 118-15-01.3W	

T. J. WOJNAR
By direction

Encl: (1) Chartlet

Copy to:
COTP LA/LB
CCGD11(ecv)
CCGD11(mps)


OUTER HARBOR
MAIN CHANNEL
SAN PEDRO BREAKWATER
RADIO MAST
47 FEET 1964-5
LOS ANGELES MAIN CHANNEL
47 FEET FOR WIDTH OF 500 FEET JAN 1964
EAST CHANNEL
PIER 1
PILOT STATION
TANK
MAY 1951

Enclosure (1)

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

MAILING ADDRESS
COMMANDER (oan)
ELEVENTH COAST GUARD DISTRICT
UNION BANK BLDG.
400 OCEANGATE
LONG BEACH, CA. 90822

16514/PF
Ser: oan 235-79

From: Commander, Eleventh Coast Guard District
To: District Engineer, U. S. Army Corps of Engineers, Los Angeles District

Subj: Dredging of Los Angeles Main Channel, Aids to Navigation Changes

Ref: (a) CCGD11 ltr 16514/PF Ser: oan 333-78 dated 10 Oct 78

1. As a result of a discussion with Mr. Dan Musslin of your staff on 27 June 1979, an update of changes of Coast Guard facilities involved in the dredging project is required.

2. The required changes as provided in reference (a) have been altered. The changes that will be necessary as a result of the dredging, along with revised cost estimates are as follows:

a. Relocate Los Angeles Main Channel Range Front and Rear Lights (LL 426 and 427).
Cost estimate $16,000

b. Require dredge contractor to remove the dolphin at Los Angeles Channel Light 6 (LL 431). The Coast Guard will rebuild the structure (should dredging extend to or beyond the light).
Cost estimate $9,000

T. J. WOJNAR
By direction

Copy to:
CCGD11 (ecv)

United States Department of the Interior

FISH AND WILDLIFE SERVICE
U.S. FISH & WILDLIFE SERVICE
ECOLOGICAL SERVICES
24000 AVILA ROAD
LAGUNA NIGUEL, CA. 92677

November 23, 1977

District Engineer
Los Angeles District
Corps of Engineers
P. O. Box 2711
Los Angeles, CA 90053

Dear Sir:

This letter is written in response to the Corps' October 27, 1977, Notice of a Public Meeting on the proposed navigation improvement for Los Angeles Harbor, California.

Although schedule conflicts make it impossible for biologists from the Laguna Niguel office to present our concerns orally, they have been expressed in this letter, which should be made a part of the official record on this project.

We have previously outlined for the Corps, in a letter of March 17, 1977 our principal objectives with regard to Los Angeles-Long Beach Harbor planning. These include:

I. Protecting the existing bottom fish and pelagic fish populations of the Outer Los Angeles-Long Beach Harbor. The bottom fish population here has been characterized as the most productive in Southern California.

II. Maintaining existing sportfishing access at Pier J and other harbor sites and providing for additional fishing access wherever possible on new structures being built.

III. Improving water quality in the harbor. This can be accomplished only if adequate water circulation is attained throughout the inner and outer harbors. Prior to implementation, all modifications of harbor contours should be carefully studied to determine effects on circulation.

IV. Maintaining and/or restoring populations of endangered species.

V. Preserving remaining wetlands and intertidal and subtidal shallows in and around Los Angeles-Long Beach Harbor.

The project, as proposed, would conflict with Objective I and could conflict with Objectives III and IV.

The impacts of the project which concern the Fish and Wildlife Service most would result from the 187-acre dredged material fill to be placed in the harbor. The fill would result in significant losses of soft-bottom and open-water habitats in the outer harbor. Studies of the Allan Hancock Foundation have shown that most of the area to be lost has relatively unpolluted bottom sediments and supports a diverse benthic invertebrate population. Fishes dependent on the soft-bottom and open-water habitats here include: the white croaker, Northern anchovy, bay goby, queenfish, white surfperch, California tonguefish and Pacific sanddab. The northern anchovy population here supports one of the most important bait fisheries in Southern California. The anchovy and other small fishes provide an important food source for the endangered California least tern. The Corps' planned 187-acre fill in the outer harbor would contribute to the continuing trend toward reduced soft-bottom and open-water habitats in Los Angeles-Long Beach harbor.

We have previously pointed out that one goal of any comprehensive harbor plan should be to minimize such fills. When these fills are made for non-water-dependent purposes they are completely unacceptable to this agency and furthermore constitute an improper use of waters under Federal navigational servitude. When made for a water-dependent purpose they may be acceptable only if habitat losses are minimized and remaining losses adequately compensated by habitat improvements in other (preferably adjacent) areas.

These matters, as well as potential impacts on harbor circulation and endangered species, have been ignored or inadequately discussed in the Corps' 1970 EIS. Impacts on the endangered California least tern are of particular concern, since this bird nests in an area (Reeves Field) immediately adjacent to the proposed fill and feeds in the outer harbor. Hopefully these impacts will be dealt with fully in the forthcoming updated EIS.

The Fish and Wildlife Service will oppose any large fill in Los Angeles-Long Beach outer harbor until we have learned the following:

1) The uses to which the filled area will be put,

2) potential impacts of the fill on circluation patterns within the harbor,

3) potential impacts on the California least tern.

The uses of the 187-acre fill would best be dealt with as a part of the Los Angeles Harbor General Plan. Prior to approval of the Corps' Navigation project, at the very least, a preliminary general plan should be completed by the Port of Los Angeles including land-use plans for the lands to be created by the fill.

We look forward to working with you in developing an acceptable Los Angeles Harbor Navigation Improvement Plan.

Sincerely,

George A. Monk

fr James J. McKevitt
Field Supervisor

GAM:gr

cc: CDFG, Marine Region, Att: Larry Espinosa, Long Beach, CA
NMFS, Terminal Island, CA
Los Angeles Harbor Dept., Los Angeles, CA
AM, Sacramento, CA

United States Department of the Interior
FISH AND WILDLIFE SERVICE
Sacramento Area Office
2800 Cottage Way, Room E-2740
Sacramento, California 95825

December 14, 1977

In reply refer to: ES-LN

Colonel Hugh G. Robinson
District Engineer
Los Angeles District
Corps of Engineers
P. O. Box 2711
Los Angeles, CA 90053

Dear Sir:

This letter is written in response to the Corps' October 27th and November 23, 1977, Notices of Public Meeting on the proposed navigation improvement for Los Angeles Harbor, California, and supersedes the November 23rd letter from the Laguna Niguel Field Office on the same subject. It has been revised to reflect the project changes described in the Corps' most recent notice. These changes include a new spoil disposal area with surface area increased from 187 to 282 acres. We were unable to prepare this letter and forward it through channels in time for your December 12th public meeting. However, we are requesting that this letter, which expresses our major concerns with the Corps project, be made a part of the official record on the project.

We have previously outlined for the Corps, in a letter dated March 17, 1977, our principal objectives with regard to Los Angeles-Long Beach Harbor planning. These include:

I. Protecting the existing bottom fish and pelagic fish populations of the outer Los Angeles-Long Beach Harbor. The bottom fish population here has been characterized as the most productive in Southern California.

II. Maintaining existing sportfishing access at Pier J and other harbor sites and providing for additional fishing access wherever possible on new structures being built.

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

III. Improving water quality in the harbor. This can be accomplished only if adequate water circulation is attained throughout the inner and outer harbors. Prior to implementation, all modifications of harbor contours should be carefully studied to determine effects on circulation.

IV. Maintaining and/or restoring populations of endangered species.

V. Preserving remaining wetlands and intertidal and subtidal shallows in and around Los Angeles-Long Beach Harbor.

The project, as proposed, would conflict with Objectives I and IV and could conflict with Objectives III and V.

The aspects of the project which most concern the Fish and Wildlife Service relate to the 282-acre dredged material fill to be placed in the harbor. The fill would result in significant losses of soft-bottom and open-water habitats in the outer harbor. Fishes dependent on these habitats here include: the white croaker, northern anchovy, bay goby, queenfish, white surfperch, California tonguefish and Pacific sanddab. The northern anchovy population here supports one of the most important bait fisheries in Southern California. The Corps' planned 282-acre fill in the outer harbor would contribute to the continuing trend toward reduced soft-bottom and open-water habitats in Los Angeles-Long Beach Harbor.

In addition to its impacts on fishery habitats (and partly as a result of these impacts), the project would impact a variety of marine-associated birds using the proposed fill area. Principal avifauna using the site include diving ducks, pelicans, shorebirds, gulls, terns, cormorants and grebes. Of particular significance, the project would have a direct impact on the endangered California least tern. The area immediately adjacent to the project fill site supports a large nesting population of least tern (in 1977, approximately 15% of the total nesting in California). For the Los Angeles Harbor least tern population more than half of the essential feeding habitat, which is currently being considered for inclusion in the least tern's critical habitat under the Endangered Species Act of 1973, would be lost as a result of the Corps' proposed 282-acre fill. Indirect impacts on least tern habitat resulting from development of the filled area may also be significant. Because of these impacts, the project will require formal consultation between the Corps of Engineers and the Fish and Wildlife Service Endangered Species Office as described in the April 22, 1976, "Guidelines to Assist Agencies in Complying with Section 7 of the

Endangered Species Act" and the January 26, 1977, "Proposed Provisions for Interagency Cooperation". This consultation should be initiated prior to any further project planning.

The preliminary judgment of the Laguna Niguel Field Office of the Fish and Wildlife Service is that the currently proposed fill would have unacceptable impacts on the California least tern. However, even if no endangered species habitat were involved, the Fish and Wildlife Service would have serious reservations about the proposed massive fill. In fact, the Fish and Wildlife Service will oppose any large fill in Los Angeles-Long Beach outer harbor until we have learned all of the following:

1. The uses to which the filled area will be put,

2. how these uses relate to overall plans for the port,

3. potential impacts of the fill on circulation patterns within the harbor,

4. potential impacts on the California least tern.

These matters have been ignored or inadequately discussed in the Corps' final EIS which was written in 1974 but released in 1976 without proper updating. As a result of the changes in the Corps' proposal and recently developed information and policy changes with regard to endangered species, it is clear that an updated EIS is required. It is our understanding that such an EIS is now being prepared. Hopefully, the matter highlighted in this letter will be more fully discussed in the forthcoming EIS.

Our general policy with regard to harbor fills can be summarized as follows. When these fills are made for non-water-dependent purposes, they are completely unacceptable to this agency and furthermore constitute an improper use of waters under Federal navigational servitude. When made for a water-dependent purpose, they may be acceptable only if habitat losses are minimized and remaining losses adequately compensated by habitat improvements in other (preferably adjacent) areas. In the case of the Los Angeles Harbor Navigation Project, the uses of any resultant fill would best be dealt with as a part of the Los Angeles Harbor Master Plan which should have as one of its goals the provision of water-dependent facilities with the absolute minimum of filling of navigable waters within the harbor.

We look forward to working with you in developing an acceptable Los Angeles Harbor Navigation Improvement Plan.

Sincerely yours,

ACTING Area Manager

cc: CDFG, Marine Region, Att: Larry Espinosa, Long Beach, CA
NMFS, Terminal Island, CA
Port of Los Angeles, San Pedro, CA

United States Department of the Interior

FISH AND WILDLIFE SERVICE

U.S. FISH & WILDLIFE SERVICE
ECOLOGICAL SERVICES
24000 AVILA ROAD
LAGUNA NIGUEL, CA. 92677

January 31, 1978

Col. Hugh G. Robinson
District Engineer
Los Angeles District
Corps of Engineers
P O Box 2711
Los Angeles, CA 90053

Attention: Dan Muslin

Dear Sir:

Thank you for sending us a copy of your response to National Marine Fisheries Service's (NMFS) letter on your Los Angeles-Long Beach Harbor Project. We are disappointed that you did not respond directly to the Fish and Wildlife Service's (FWS) December 14, 1977 letter. However, your letter to NMFS does respond to one of our major points - mitigation and/or compensation of habitat losses which will result from the proposed fill in the outer Los Angeles harbor.

You claim that mitigation is unnecessary, because it has not been identified as a requirement of the project in Public Law 94-587, Document 94-594, or in Principles and Standards Addendum to the chief of Engineers Report. You fail to mention why mitigation needs are not identified in any of these documents. The reason is quite simple - the project has never been properly coordinated with the FWS as required by the Fish and Wildlife Coordination Act. The need to consult with the FWS is clearly spelled out in the following language of the act:

> SEC. 2. (a) Except as hereafter stated in subsection (h) of this section, whenever the waters of any stream or other body of water are proposed or authorized to be impounded, diverted, the channel deepened, or the stream or other body of water otherwise controlled or modified for any purpose whatever, including navigation and drainage, by any department or agency of the United States, or by any public or private agency under Federal permit or license, such department or agency first shall consult with the United States Fish and Wildlife Service, Department of the Interior, and with the head of the agency exercising administration over the wildlife resources of the particular State wherein the impoundment, diversion, or other control facility is to be constructed, with a view to the conservation of wildlife resources by preventing loss of and damage to such resources as well as providing for the development and improvement thereof in connection with such water-resource development.

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

The Corps of Engineers (CE) has failed to carry out this consultation requirement of the Act. The only coordination with us consisted of transmitting their 1973 Interim Review report and draft EIS to us for review. That review indicated concern for endangered species and destruction of aquatic habitat due to filling and stated that further coordination would be required to reduce those adverse effects. It did not constitute a Fish and Wildlife Coordination Act report. A letter from your office, dated January 9, 1974, indicated your office intended at that time to provide the necessary coordination under the act. However, the only coordination forthcoming was invitations to attend the informal and unofficial Harbor Liaison Group meetings which we did. It was at one of these meetings, in August 1975, that we were informed that an addendum to the Interim Review Report, dated January, 1975, had been prepared and submitted without review by FWS. This was intended to comply with the Water Resource Council Principles and Standards. A letter from this office, dated August 15, 1975 expressed our dismay at CE's failure to coordinate and indicated that mitigation was possible and should be made. We received no response to that letter.

Despite our limited opportunity for coordination and contrary to the Principles and Standards addendum to the Chief of Engineers Report, the Department of Interior's review of the Interim Review report DEIS did point out major unresolved environmental problems and the need for mitigation measures in the following statements:

> "The nesting colony of least terns at the mouth of the San Gabriel River and least terns that are attempting to reestablish on Terminal Island may be adversely affected by the proposed project".
>
> "Another direct impact that should be more fully described is the permanent loss of the aquatic environment in the area of the proposed fill. Also, the 10 million cubic yards of dredge spoil will occupy approximately 6000 acre-feet of aquatic marine habitat".
>
> "Further coordination is recommended between our agencies to modify construction techniques so as to reduce any adverse effects the project will have on the endangered species and the anchovy fishery".

Such coordination has never taken place. We believe the Corps of Engineers can begin to correct this problem by meeting in the near future with personnel from the Fish and Wildlife Service, National Marine Fisheries Service, and California Department of Fish and Game to discuss their concerns.

We look forward to working with you in the development of the Los Angeles Harbor Navigation Plan.

Sincerely yours,

James J. McKevitt

James J. McKevitt
Field Supervisor

GAM:hc

cc: CE, ERB, Los Angeles, CA
CDFG, Region 5, Long Beach, CA
NMFS, Terminal Island, CA
AM, Sacramento, CA

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Ecological Services
24000 Avila Road
Laguna Niguel, CA 92677

April 17, 1978

Mr. W. Calvin Hurst
Harbor Environmental Scientist
Port of Los Angeles
P. O. Box 151
San Pedro, CA 90733

Dear Mr. Hurst:

This letter responds to your March 17, 1978, memorandum requesting our comments, concerns, and mitigation measures relating to the preparation of a draft EIR for the U. S. Army Corps of Engineers Los Angeles Harbor deepening project.

The Fish and Wildlife Service has expressed its major concerns with regard to impacts of the harbor deepening project in several letters to the Corps of Engineers. The most comprehensive of these was our Area Manager's letter of December 14, 1977 (copy attached). Although the proposed fill location has been moved slightly to the west of its previous position (reducing the loss of essential least tern feeding habitat from approximately 50% of the total to approximately 30%), all of the concerns expressed in our December 14th letter remain valid.

Our two most important concerns can be summarized as follows:

a) That least tern habitat be preserved. The Endangered Species Act of 1973 requires that Federally authorized, funded, or constructed projects shall not jeopardize the continued existence of an endangered species or adversely modify its critical habitat.

b) That losses of marine habitat be minimized and that any losses of such habitat occurring as a result of spoil disposal be compensated by an equivalent enhancement of habitat.

We will recommend against project implementation until these concerns have been adequately resolved.

Several issues which must be dealt with in the Port's forthcoming EIR have been highlighted in the following recent developments:

1) The Corps' statement, in their 17 January 1978 letter, that they have no authority to participate in any mitigation or compensation for this project,

2) The Resources Agency of California's proposal (letter of 4 April 1978) for compensation of losses to marine habitat and least tern feeding habitat, and

3) The initiation of formal consultation under Section 7 of the Endangered Species Act of 1973 between the Corps of Engineers and the Fish and Wildlife Service.

If the Corps is correct in its position that it has no authority to provide mitigation/compensation, then such mitigation/compensation must be the responsibility of the Port. Your EIR should clearly state whether the Port, the Corps, or both parties will take responsibility for the required compensation. It should also describe various possible mitigation/compensation proposals both within and outside the harbor. This discussion should include the measures proposed in the Resources Agency's April 4th letter, particularly their proposal for the preservation of Reeve's Field as a permanent least tern nest site.

The EIR should also point out that neither the compensation program nor the Corps project can be finalized until the formal endangered species consultation now underway between the FWS and Corps has been completed. In fact, it remains unclear at this time whether any of the fill proposals which have been recommended by the Port of Los Angeles can be considered acceptable under Section 7 of the Endangered Species Act regardless of mitigation measures.

Of course, this entire problem with endangered species impacts could be avoided by selection of alternative spoil sites. Alternatives include other locations in the harbor, offshore disposal sites, and upland disposal sites. We believe, therefore, that the matter of alternative sites (and impacts at each site) should be given special consideration in the EIR. The EIR should also describe the long-term plans for filling and development in Los Angeles Harbor and explain how the alternatives under discussion relate to these long-term plans.

In addition to the major concerns discussed above, we have several new questions regarding the material you sent us with your memorandum. The project description includes a number of features which do not appear to be part of the Corps project. These are:

1) The additional dredging of approximately 1,500,000 cubic yards of material to be paid for by the Port.

2) Additional dredging by the Corps of Engineers in the supertanker approach channel and at the breakwater as requested by the Coast Guard.

3) Possible relocations of industrial sewers and storm drain outfalls.

4) Removal, relocation, or replacement of existing submarine pipelines and cables crossing harbor channels at elevations which would be in conflict with the dredging.

The EIR should make very clear which of these are authorized as part of the Corps' project and which are the Port's own projects. It should also describe what Federal permits will be required for these and other actions related to the Corps project.

Thank you for the opportunity to comment on this project early in the EIR process.

Sincerely,

George A. Monson

for James J. McKevitt
Field Supervisor

GAM:gr
Attachment

cc: CDFG, Region 5, Long Beach, CA
NMFS, Terminal Island, CA
CE, Engineering Div., Att: D. Muslin, C. Grooms, Los Angeles, CA

United States Department of the Interior

FISH AND WILDLIFE SERVICE

ECOLOGICAL SERVICES
24000 Avila Road
Laguna Niguel, CA 92677

June 29, 1979

District Engineer
Los Angeles District
Corps of Engineers
P.O. Box 2711
Los Angeles, CA 90053

Re: Los Angeles Harbor Deepening Project

Dear Sir:

This letter constitutes a planning aid letter, provided by the U.S. Fish and Wildlife Service (FWS) to the Corps of Engineers (CE), to assist the CE with the preparation of the draft supplement to the Environmental Impact Statement for the Los Angeles Harbor Deepening Project, also known as the "Interim Dredging Project". The supplement to the Environmental Impact Statement (EIS) was thought to be necessary due to inadequacies of the EIS upon which earlier project decisions were based. This report is for planning aid purposes and does not constitute the report of the Service or the Department of Interior as required by Section 2b of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.). The interim dredging project was authorized by Congress in 1976 without fulfillment of this requirement. This letter is not a part of the consultation required by Section 7 of the Endangered Species Act, nor does it offer any specific discussion or recommendations regarding project impacts upon the endangered California least tern. For Fish and Wildlife Service opinions with regard to the relation between this project and the California least tern, see FWS letters dated 27 September 1978 and 3 April 1979.

Because of the length of the letter, a brief summary is included.

<u>SUMMARY</u>
The Los Angeles Harbor Deepening Project consists of dredging the entrance and main channel of the harbor to permit navigation of ships with deeper drafts. The Port of Los Angeles (Port) is sponsoring additional dredging and a harbor fill disposal site for dredged material. The CE and the Port are participating in the construction of

a 'mitigation area' to replace some of the biological losses of the proposed fill.

The harbor area supports a rich and productive marine fish community with white croaker, queenfish, northern anchovy, and tongue fish usually most abundant. Species important to the recreational fishery are also well represented (e.g. halibut, basses, corbina, bonito, barracuda, jacksmelt, sharks). The harbor also supports a diverse and abundant group of water-associated birds. Seagulls are most numerous but many other species use the harbor (e.g. pelicans, terns, cormorants, grebes, waterfowl, and wading birds).

The adverse impacts of the dredging would be relatively minor and short-term and would cause slight, temporary reductions in some fish populations. The proposed fill disposal site would cause major and permanent damage to the marine ecosystem. Fish and water-associated bird abundances would decline in the harbor because the fill would reduce the harbor's capacity to support existing population levels. Fish nursery grounds and water-associated bird feeding areas would be permanently eliminated. The 'mitigation area' would replace some of the fish nursery and bird feeding habitat lost in the fill area but none of the harbor carrying capacity losses.

Recommendations are made to eliminate or reduce adverse impacts on fish and wildlife resources.

THE PROPOSED PROJECT

The 'interim project' proposal calls for dredging about 305 hectares of harbor bottom within the main channel and inner harbor of the Port of Los Angeles (see Figure 1). Existing channel depths are about minus 35 feet mean lower low water (MLLW). The proposed dredging would lower the channel bottom to minus 45 feet MLLW to permit the passage of larger ships with deeper drafts. The dredging would take about 18 months to complete. Most of the apparent benefits of the project accrue from transportation savings ($20 million/yr.) achieved by the use of fewer, larger, and more efficient vessels. It is planned that 8 million cubic yards of the CE sponsored dredged material, along with an additional 4.5 million cubic yards of Port sponsored dredged material, would be used to create 76 hectares of new land in the outer harbor. The location of the proposed fill is south of the end of Ferry Street and east of Fish Harbor, in an area of open water having depths averaging about 16 feet below MLLW (see Figure 2). The southern shoreline of Terminal Island would be extended between 600 and 1,000 yards into the harbor. Dike construction would take about 18 months. The project now includes the additional construction of a biological 'mitigation area'; an area of

about 50 hectares of harbor waters where clean (non-polluted) dredged material would be deposited. This would create a shallow water marine habitat with water depths averaging about 10 feet below MLLW. The 'mitigation area' would be east of the proposed fill, south of the Seaplane Anchorage and west of the Navy Mole, in an area of open water with existing depths exceeding 20 feet below MLLW. The southern, exposed margin of the 'mitigation area' may be partially closed with a jetty created by extending the east-west dike of the fill to the east for 1,000 feet.

Total project costs are expected to exceed $40 million, with more than half that being paid by the Port of Los Angeles. A large part of the costs incurred by the Port is due to construction of the spoil disposal containment dike ($14.6 million). The remaining costs include: the CE dredging (about $17 million), the Port's dredging (about $6 million), and utility relocation ($2 million).

THE BIOTA OF THE PROJECT SITE

For an overview of the biological resources and status of San Pedro Bay, please refer to our planning aid letter dated 6 February 1979. The biology of Los Angeles Harbor was studied rather intensively during the first half of this decade (Harbors Environmental Projects 1971-1975[1]). However, this comprehensive study was terminated in 1976. Since then, the sampling in the harbor has been relatively limited in scope, providing piecemeal information on the biological status of the harbor. In the years since 1976, two major events have significantly influenced the marine ecosystem within the proposed fill area: a) the initiation of secondary treatment of sewage discharged into the harbor from the Terminal Island Treatment Plant, previously primary treated effluent was discharged; and b) the diversion of tuna cannery wastewater discharges through the Terminal Island Treatment Plant. The Harbors Environmental Projects (HEP) resumed limited sampling in late 1977 and continued through 1978 to determine the biological impacts of these actions.

The area within the bounds of the proposed fill has not been studied in a comprehensive manner by HEP or any other entity to determine the impacts upon the marine ecosystem of the filling or of the cannery/treatment plant discharges. Since the proposed fill site

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[1]Marine Studies of San Pedro Bay, California and Environmental Investigations and Analyses, Los Angeles-Long Beach Harbor, 1973-1976 Harbors Environmental Projects.

contains a dynamic biological system which is in the process of readjusting to major environmental changes (upgraded quality of effluent discharges), and since it has not been adequately examined for its biological resources, some amount of uncertainty is interjected into any estimation of probable project impacts.

There are no significant terrestrial plant or animal resources within the project area since the area has been completely altered by man. Marine mammals would not likely be effected by the project. The significant organisms which are potentially impacted by the project are all within three general categories: benthic or bottom-dwelling marine organisms, marine organisms found within the water column, and water-associated birds.

The Benthic Community. Due to the massive scale of the total project, a detailed account of the bottom communities is not practicable, herein. However, some important generalities can be mentioned. The nearly 200 species of marine organisms, mostly polychaete worms and snails which live in and on the bottom of Los Angeles harbor, are extremely important to the marine ecosystem. These organisms are significant because they represent food for a diverse group of predators. That is, they are fundamental to the web of energy interdependence in the marine ecosystem. They also make a significant contribution to the decomposition and recycling of nutrients in the harbor.

The actual species, numbers, and biomass of benthic organisms per unit of area varies with each location in the harbor. Species richness falls within the range of 1 to 60 species per square meter, abundance ranges between 30 and 80,000 individuals per square meter, while biomass ranges between 1 and 500 grams per square meter. Several trends are evident along a sampling transect from the inner harbor (main and side channels, and slips) to the outer harbor (anchorages and breakwaters). The diversity of species is greater in the outer harbor as opposed to the inner harbor. The biomass, or weight of living organism, per unit of bottom area is much higher in the outer harbor than the inner harbor. Similarly, abundance is usually higher in the outer portions relative to the inner portions of the harbor. These trends have resulted primarily from the greater stresses manifested in the inner harbor areas. Stresses which have adversely influenced the benthic community in the inner harbor include: higher concentrations of toxic pollutants, a wider range of temperature fluctuation, and a higher frequency of dissolved oxygen depletion. Inadequate circulation of better quality water from outside the harbor contributes to the detrimental influence of these stresses.

It has been suggested[2] that the greater abundance and biomass of the benthic community in the central areas of the outer harbor are due to nutrient enrichment. The unnatural nutrient sources were formerly the tuna cannery effluents and the Terminal Island Treatment Plant primary treated effluent. Presently, the Terminal Island Treatment Plant is the only major point source of unnatural nutrients (secondary treated effluent) into the Los Angeles outer harbor. When the canneries were discharging directly into the water east of Fish Harbor, the noxious conditions created near the discharge prevented the development of a healthy benthic community there. Since the termination of direct cannery discharge into the proposed fill area, the benthic community has made a very good recovery and is becoming increasingly similar to the remainder of the central outer harbor, with higher species richness and abundances.

Though seasonal variations can be considerable, the average biomass of the benthic community within the proposed fill area should eventually approximate the average of the outer harbor, 200 grams of living animal tissue per square meter of bottom area. The more stressed main channel and inner harbor areas support an average biomass of about 20 grams per square meter of bottom area. Using these estimations and the areal estimations of the proposed project site (305 hectares of bottom to be dredged, 76 hectares of fill, and 50 hectares of 'mitigation area' filling), it is possible to summarize the benthic biomass potentially influenced by the project. The area to be dredged should contain a minimum of 60 metric tons of living benthic animal mass, while the areas to be filled or partly filled should contain about 250 metric tons of biomass. This yields a total estimate of about 310 tons of benthic organisms living within the project area of 431 hectares.

The next step in the food chain has never been studied in the harbor; that is, how much benthic biomass is devoured by predators in the water column. It is unknown just how much fish biomass is supported by a given area of harbor benthos. It is known that some portion of the benthic biomass contributes to the growth and sustenance of higher trophic levels. It is also certain that changes in the availability of food, as embodied in the benthic community, have a direct impact upon the organisms feeding upon it, as embodied in the fishes. Whatever

[2]Ecological Changes in Outer Los Angeles-Long Beach Harbors Since the Initiation of Secondary Waste Treatment and Cessation of Fish Cannery Waste Effluent at Terminal Island, California, Harbors Environmental Projects, 1978.

diminishes the carrying capacity of the harbor ecosystem diminishes the abundance of these dependent organisms.

Water Column Community. It should be recognized that some of the fishes to be included in this grouping, despite strong affinities to the benthos, are still capable of entering the water column. Others associate with the benthos in a facultative manner. Conversely, most benthic organisms have planktonic life stages which are found in the water column at times. The purpose of these liberal groupings is to simplify the discussion and subsequent analysis of project impacts.

The "comprehensive" marine biological studies of San Pedro Bay, unfortunately, did not include any direct fish data gathering from within the area of the proposed fill, 'mitigation area', or the Seaplane Anchorage. The inner harbor had only one trawl station and one gill net station, although later studies within Long Beach Harbor have supplemented the inner harbor collections. This lack of sample sites resulted primarily because the intention was to analyze the impact of port master plan developments rather than the 'interim' project. Given the above caveates, some generalities drawn from these earlier studies are pertinent and, therefore, worthy of mention.

Trawl surveys in the harbor established that fewer than ten species of fish account for more than 90% of the total abundance. The most abundant fish species are white croaker, northern anchovy, queenfish, bay goby, tonguefish, white surfperch, shiner surfperch, California butterfish, calico rockfish, and speckled sanddab. Clearly the single most abundant fish species in the harbor is the white croaker, *Genyonemus lineatus*. There are more than 130 species of fish known from Los Angeles and Long Beach harbors, with about 60 of these species considered to be common. The ichthyofauna of outer Los Angeles and Long Beach Harbors is basically similar in composition to the adjacent waters outside the breakwaters and interchange between the two areas is considered to be important to fish populations of both areas. The outer harbor fish community is healthy, diverse, and very productive. The Los Angeles inner harbor ichthyofauna is not as well studied but diversity is known to be below that of the outer harbor. Fish abundance in the inner harbor is lower than that of the outer harbor. White croaker and queenfish seem to comprise an even larger proportion of the fish community in the inner harbor than in the outer harbor. This is probably due to the greater environmental stress of the inner harbor (e.g. lower D.O.), of which the croakers are more tolerant.

The northern anchovy, virtually absent from the inner harbor, is an important link in the marine food chain in the outer harbor and offshore. Since sampling methods used in the harbor are poorly suited

for quantitative sampling of anchovy, the abundance data are undoubtedly under-estimations of actual stocks. The harbor area is apparently no more a preferred habitat for adult anchovy than outside the harbor. Though schools of anchovy frequently transit the area, abundance is usually highest in the late summer. The inshore waters seem to be a preferred habitat for juvenile anchovy where they account for most of the changes in abundance. The decline in anchovy abundance throughout the southern California bight is also noted in the harbors.

The nursery function of the outer harbor is very important to many fish. The abundance of fishes within the harbor is usually higher in summer than winter. Much of the change in abundance is due to the presence of large numbers of juvenile fishes which emigrate from the harbor during the winter. Fish spawning is more intense outside the harbor, though some species do spawn inside. Juveniles (larger than larvae but sub-adult) of many species of fish seem to seek out inshore waters. Conditions thought to provide a beneficial environment for many types of juvenile fishes include: good water quality, slightly warmer temperatures, abundant plankton, configuration (semi-enclosed or protected in some manner), and relatively shallow water depths. The role of the harbor as a fish nursery has not been adequately quantified, but it is undoubtedly very important to fish populations of the region.

Abundance information is not the complete picture, because where there are many small fish, there will be larger fish and birds eating them (e.g. bonito, barracuda, halibut, cormorants, terns, etc.). A larger predatory fish may contribute 2% of the abundance and 20% of the biomass of a fish community. Based on trawl information from 1972 and 1973, demersal fish biomass in San Pedro Bay was estimated at up to 1,600 metric tons of fish with productivity estimated at 890 tons per year.

The anchovy is the only species considered to be commercially important; much of the local anchovy bait fishery is dependent upon San Pedro Bay. Other species are sold as fresh fish, and many have considerable recreational and nutritional value. Much of the harvest capability of the outer harbor is presently unexploited. Without doubt, the entire marine ecosystem of the region is significantly interrelated with that of the harbor.

Because no fish sampling of any kind had been conducted within the proposed fill area, the Fish and Wildlife Service began sampling the area using an otter trawl and gill nets. Trawls were taken within the proposed fill area, the Seaplane Anchorage, and the proposed 'mitigation area' next to the Navy Mole during the months of August through November 1978.

The two major fish sampling methods, otter trawls and gill nets, tend to bias the catch in different ways. An otter trawl catches fish that are on or near the bottom and are either too slow or too small to avoid the moving net. Trawl catch data also tend to overestimate the proportion of juveniles while underestimating species diversity and biomass. The gill net catches more of the larger motile fish and fishes which associate with structures. Usually, the general trends of the most abundant species are consistently reported by the two methods. But, as mentioned earlier, the actual biomass of fishes estimated from trawl catches can be in considerable error on the low side. Depending upon the design of the trawl and speed of the tow, a given otter trawl may sample between 12% and 30% of the fish that are actually in its path. Some important larger fishes contribute much more to the harbor standing stock than trawl surveys indicate.

This sampling effort by FWS yielded 30 species of fish from 17 families (see Table 1), taken during 10 trawls and 64.3 hours of gill net sets, (see Tables 2 & 3).

The trawls averaged 8.2 species per trawl, 321 individual fish per trawl, and 6.26 kilograms per trawl. Calculations, using an average area swept by the trawl of 2,340 square meters, show a density of 13.7 fish caught per 100 square meters of bottom swept. These data translate into 270 grams of fish per 100 square meters of bottom swept. If the trawl used to collect these fish (with an effective opening of less than 3 meters) is assumed to have an efficiency as good as 25%, then actual density and weight of fish in the vicinity of the proposed fill during the fall of 1978 was between 13.7 and 54.8 individuals/100m^2 and 270 and 1080 grams/100m^2 of bottom.

Considering the area of the proposed fill, 76 hectares (190 acres), it is estimated that between 2 to 8 metric tons and 100,000 to 400,000 individuals of the demersal fish community were located within the bounds of the proposed fill during the fall of 1978. The most abundant fishes in the trawl catches were white croaker, queenfish, and northern anchovy. For the latter two species, this was due to the large numbers of juveniles caught. However, California halibut ranked in the top five (comprising 8.8% of the total weight) when biomass was considered.

The gill net sampling data show a different perspective. Where the average weight of a fish caught in the otter trawl was 19.5 grams, the average weight of a fish caught in the gill nets was 324 grams. While white croaker and queenfish were still among the most abundant species taken, the number of jacksmelt caught in the gill nets far exceeded them. When ranked by weight, the top seven species in the gill net catch were completely missing from the trawl catches, except for bat

rays. The meaning of this is that trawl information alone is incomplete and biased. In particular, species of some importance to the recreational fishery, e.g. corbina, bonito, sharks, jacksmelt, and barracuda, are grossly underestimated by trawl surveys. Unfortunately gill net catch data are not suitable for calculation of density estimates. Therefore, the populations of many species of fish in the harbor, important to the marine ecosystem and to human interests, are not adequately evaluated as to their presence or relation to other species.

The catch per unit of effort during August was very much lower than subsequent months. This was a result of a failure at the Terminal Island Treatment Plant which discharged an untreated effluent, through July and August of 1978. This created a highly polluted zone within part of the study area. Motile organisms avoided the outfall plume. This zone of avoidance, created by the noxious discharges, dissipated when effluent quality improved in September. (The effect upon the benthic community is more adverse since the residents cannot effectively move out of the area with stress conditions.) Adequate dilution of the treatment plant discharges is clearly very crucial to reducing the adverse impacts associated with the point discharge. Stimulation of some part of the marine ecosystem by the tuna cannery or Terminal Island Treatment Plant discharge seems likely, but has not yet been well established. The declines in white croaker and northern anchovy abundances seem to account for most of the fish abundance changes in the harbor since 1973 and 1974. This seems to show that removal of much of the organic load from the cannery discharges to the harbor caused a decline in those species. However, fish abundance in all southern California coastal areas seems to have declined since 1974, with a leveling off in recent years. The trend in abundance had been upward in Long Beach Harbor since 1975 with a slight decline in 1978. The trawl surveys in Long Beach Harbor do not seem to support the contention that the cessation of tuna cannery discharges and primary sewage discharges in Los Angeles Harbor caused a decline in fish abundances throughout the harbors. The coastal trawl surveys by the Southern California Coastal Water Research Project seem to indicate that large-scale environmental influences are influencing fish abundances in ways that are not well understood.

Water-associated Birds. Bird surveys in Los Angeles and Long Beach Harbors in the middle 1970's established that the vicinity was heavily utilized by many species of birds for resting and feeding. Eighty species have been observed. About half that number of species are considered to be relatively common. Many species, being migratory, are seen in the harbor area seasonally. The birds observed most frequently were several species of seagull, surf scoter, and the brown pelican.

The distribution of species throughout the harbor and the utilization of different areas by species was found to be uneven. Some areas were seldom used by any birds, (e.g. just inside the San Pedro breakwater; just outside the entrance to the southeast basin; the Cabrillo launch ramp; slip One LA; and the west end of the Navy Mole) probably due to human disturbance and/or poor conditions. Other areas were used almost entirely by gulls, including virtually all of the middle and inner harbors. The areas which have the greatest diversity of bird species are: the middle breakwater; parts of the southeast and east basins and Cerritos Channel in Long Beach; southern edge of the Navy Mole; part of the Cabrillo shallow area; and most of the shoreline and water area of the proposed fill and Seaplane Anchorage. A high diversity and abundance of water-associated birds utilize the protected breakwaters and sandy beaches where human disturbance is minimal.

The behavior of birds was categorized into general categories of feeding, resting, flying, and feeding and resting. It was discovered that feeding, and feeding and resting activities were concentrated within the outer harbor, and in particular, the area of the proposed fill, the sandy area near the Cabrillo Museum, Navy Mole, Seaplane Anchorage, and the outer breakwaters. Resting areas were primarily in the enclosed and/or protected areas like Fish Harbor, West Basin, Channel 2, and isolated breakwaters and docks, like the Seaplane Anchorage and main breakwaters. Very few birds are known to nest in the harbor area.

Two federally listed endangered species are found in the harbor area, the California least tern and the brown pelican. The brown pelican feeds and rests in the harbor, especially in the Seaplane Anchorage and the proposed fill area, and along the outer breakwaters. It is likely that the fish concentrations of the outer harbors are significant and vital food resources for the brown pelican. The least tern feeds, rests, and nests in the harbor area. In recent years, nesting activity has been near the Seaplane Anchorage and interim fill area; feeding and resting activities are limited almost entirely to the triangle of water composed of the Seaplane Anchorage, proposed interim fill area and the Navy Mole.

A recent study (HEP 1978) seems to indicate a declining trend for total bird abundance in the outer harbor since 1974. This is due almost entirely to fewer gulls and surf scoters. Many other species (e.g. grebes, pelicans, and cormorants) are increasing. In the major studies of water-associated birds in the harbor, the vicinity of the Seaplane Anchorage and proposed fill has consistently been identified as a significant feeding and resting area. Observations during 1978 (by FWS, HEP, and California Department of Fish and Game) indicated that at least

43 species of birds were using the proposed fill (see Table 4). This area and the Seaplane Anchorage are important because they offer a variety of feeding and roosting substrates, favorable feeding conditions and are relatively free of human disturbance. Although there are no data to quantify the significant contributions of these areas to the sustenance of many bird species, we do note that throughout the year the highest average species diversity and average number of individuals, along with considerable feeding activity are found in the proposed fill and the Seaplane Anchorage areas.

EXPECTED PROJECT IMPACTS

Dredging. Proposed dredging of the main channel and contiguous areas, would have minimal direct impacts upon water column organisms and water-associated birds. Motile organisms (birds and fish) are able to avoid the dredge intake and the disturbed area of the operation. The secondary effects of turbidity are expected to be localized and minimal. The relatively light amounts of suspended sediments generated at the cutterhead of the hydraulic suction dredge, may cause reduced dissolved oxygen levels and some gill abrasion in fishes, which can result in an increased mortality rate. Turbid waters also interfere with capture of prey by predators that feed using visual stimuli (e.g. diving birds and some fish). Most bird feeding activities occur in areas other than the main channel. At any given moment, the turbid water area at the dredge cutterhead is expected to be relatively small. However, the continuous dredging, for 1-1/2 to 2 years, virtually guarantees a low-level, chronic aggravation, primarily of fishes and plankton. Since the fish species found in the inner harbor are among the most tolerant ones, any fish population changes resulting from the turbidity should be undetectable. Localized reductions of phytoplankton and zooplankton populations would result from the turbidity and reduced dissolved oxygen levels. Because the turbidity plume at the dredge cutterhead should usually be relatively small and confined to the deeper depths, no significant changes to the plankton community should result. However, reduction of plankton abundance over several years could adversely influence the rest of the food chain, as well as some adult populations of benthic or attached organisms which have planktonic life stages. Due to the natural variability of plankton populations, these adverse influences are likely to remain undetectable.

Contaminating heavy metals, sulfides, and nutrients, could reenter the water column from the disturbed benthos. Heavy metals can be concentrated in animal tissues as they are passed along the food chain. Nutrients could stimulate some phytoplankton or algae growth. Removal of contaminated sediments is, of course, a long-term improvement which

reduces the likelihood that contaminants would be resuspended by the propwash of passing ships.

The impacts of the dredging upon the benthic community would be more significant. Each square meter of bottom dredged eliminates that much feeding area for demersal fishes, and that much benthic community which is a source for plankton organisms and new bottom colonists. After an area has been dredged, bottom dwelling organisms begin to repopulate almost immediately. However, it takes as much as two years for biomass and species diversity to recover to pre-dredging levels. Over nearly two years of dredging, about 60,000 kilograms of living animal tissue would be destroyed within the 305 hectares of harbor bottom to be dredged. This represents a considerable quantity of prey items for fish.

Because of the expected change in sediment quality and grain size, it is likely that the "recovery" community would be different from the existing community. The additional 10 feet of depth is not expected to make a difference to the organisms which repopulate the new bottom. The 1-1/2 to 2 years of nearly continual dredging disturbance of some part of several hundred hectares would cause a reduction in the carrying capacity of the harbor. This loss, along with losses due to similar and simultaneous projects in the Naval Station and Port of Long Beach, could cause a significant disturbance to the marine ecosystem, especially the demersal fish component.

The relatively recent experimental kelp transplants on the inside of the San Pedro breakwater are likely to suffer from increased turbidity and sedimentation generated by the dredging. The existing water clarity seems to limit kelp growth and recruitment to depths less than about 15 feet. Add to this a further decrease in water quality caused by the nearby channel dredging, and the kelp may be able to grow only in the range from the surface to about five feet below mean lower low water, if at all.

Current velocities in the inner harbor are already low. Deepening the channel would reduce current speeds and increase the turnover time for water in the Inner Harbor. This could slightly aggravate water quality problems of that part of the harbor, by reducing the effect of tidal flushing. Adequate exchange of water is important to the maintenance of proper dissolved oxygen levels, dispersal of accumulating wastes, introduction of nutrients, and colonizing larvae. No long-term or significant change in the water quality of the inner harbor is expected, though.

The removal of cross-channel pipelines and utility conduits could have slightly greater adverse turbidity and water quality impacts than the hydraulic dredging due to the use of a clamshell dredge or jetting, both of which would suspend much more sediment. Twelve pipelines are to be removed and two new ones added. Adverse impacts, especially the resuspension of sediments, could span several months and be relatively chronic near the pipeline corridors. It is expected that some number of barges, tugs or boats, and other waterborne construction equipment related to the dredging would be moored, from time to time, in the Seaplane Anchorage. The disturbance caused by these activities would degrade bird roosting and feeding activities there. If the disturbances were ephemeral and intermittent, no significant harm should result.

It is expected that structural alterations to some berths would be needed to adjust for the new 45 foot draft, but details are not available. Therefore, the impacts of these measures cannot be assessed now and should be assessed individually at a later time.

In summary, the dredging portion of the project contains some adverse elements. The benthic community in the area dredged first probably would not have recovered by the time the last area was dredged. In the interim, the carrying capacity of the ecosystem will be diminished. But, within a few years after completion of the dredging, the benthic community should stabilize. The large scale and chronic disturbance during the two year period, and the 60 metric tons of biomass lost, seem unavoidable. However, the chronic disturbance can be mitigated by employing the best available dredging technology to minimize the resuspension of sediments and the associated problems.

Disposal of Dredged Material. The estimated benefit/cost ratio is favorable enough to permit disposal of the spoil either by harbor fill, ocean dumping, or inland disposal and the project would still be economically feasible. Of the three disposal choices, the fill is the most environmentally damaging. Inland disposal is the most expensive, but with a suitable site, the least damaging to fish and wildlife resources. Ocean disposal is slightly more expensive than the fill and considerably less damaging to fish and wildlife resources than the proposed fill.

The adverse impacts of ocean dumping of the dredge spoil are twofold: the reintroduction to the water column and benthos of contaminants formerly isolated in the bottom and the destruction of the benthic community at the dump site. Because no bioassay has yet been completed, it is unknown whether contaminated portions of the dredged material could be disposed in the ocean. A general comparison of the benthic communities at the designated ocean disposal site and the proposed

harbor fill site indicates the ocean site to be 600 feet deeper, disturbed by previous disposal activities, and with lower biomass, abundances, and productivity than the harbor site. Though undisturbed deepwater benthic communities have a high faunal diversity and are slow to recover from perturbation, the damages of ocean disposal to the marine ecosystem are minimal when compared to the damage of a fill in shallow water.

Similarly, the biological losses at an inland disposal site would be negligible, provided it were selected with care. Due to the urban sprawl in the metropolitan area, no suitable inland disposal sites were identified within tens of miles. Other low-lying land areas within the general harbor vicinity may be suitable, however.

Land areas (principally in Long Beach) have subsided due to oil extraction and must be raised to be adequately above sea level. However, even though both of the Ports, Los Angeles and Long Beach, operate within the realm of the public trust, political boundaries represent considerable barriers. As competing entities, the two ports do little to coordinate or cooperate on their major construction or planning efforts. One result of this situation is that Long Beach is proposing 8 million cubic yards of unnecessary dredging to make land at Pier J, while Los Angeles proposes to make unnecessary land in order to dispose of 12.5 million cubic yards of main channel dredging material. It is hoped that the Corps of Engineers' LA-LB Review of Projects will help to remedy such inconsistencies.

The damage to the marine ecosystem from the proposed harbor fill is total and permanent. This total and permanent destruction is similar to the dredging and filling of 1,500 acres of salt marsh, mudflat, and estuary that formerly existed where the harbor now does. Seventy-six hectares (190 acres) of productive benthic community containing as much as 150 metric tons of living organisms would be eliminated. Of the 2 to 8 tons of demersel fish within the proposed fill, some would be killed when trapped behind the dikes, some would starve when crowded into other areas of the harbor, and some would leave the harbor. The net result is a loss of many tons of fish biomass from the harbor ecosystem. More than 70 hectares of the remaining few hundred hectares of shallow water habitat (less than 20 feet deep) in the harbor would be eliminated. This shallow water habitat makes tremendous contributions to the rearing success of many species of fish. These shallow water areas are also among the most heavily utilized for feeding by water-associated birds (e.g. terns, comorants, and pelicans) probably because of the relative concentrations of small and juvenile fishes and the shallowness of the water. The precise role of several wrecked ships in this area is uncertain, but they are known to offer roosting habitat for birds and

probably serve as cover to attract fishes. Nevertheless, the loss of these hulks, as biological environments, seems minimal compared to the rest of the project impacts.

Seventy-six hectares of photic zone (the surface layer of water within which most photosynthesis occurs) would be eliminated. The resulting loss in primary production may well be deferred to other parts of the harbor. The reduced water surface area coupled with increased channel depths (out of the photic zone) would cause a reduction in the total energy input available for photosynthesis. The nutrients available would be carried elsewhere and could, therefore, be used elsewhere in the photosynthetic process.

The sediment lost and the turbidity resulting from the diked disposal area should be minimized by the intended use of overflow weirs, silt screens, and a filter cloth. However, even at low concentrations, as discussed earlier for the dredging, the chronic turbidity at the discharge sites would adversely impact areas and the biota adjacent to the proposed fill. These discharges would also be the main reintroduction point for contaminants released from the dredged material.

The existing rocky shoreline organisms which would be enclosed within the proposed fill site (i.e. mussels, barnacles, limpets, algae) would be destroyed. Similar organisms should reoccupy the new shoreline (the dike) within a few years of its completion. Because the dike would have a greater length than the existing shoreline, there would be a net increase of rocky subtidal substrate available for recolonization. The potential net increase of biomass on the rocky substrate would, in small part, replace some of the massive losses due to the fill. However, the contribution to the marine ecosystem of the organisms involved in the trade-off are very different. Most rocky shoreline organisms are filter feeders, straining the water for their food, while soft bottom organisms are mostly deposit feeders, deriving energy from nutrients in the mud. The fishes usually associated with each substrate type are also different. Biomass and productivity of the present rocky shoreline community is virtually unknown. The present shoreline community is somewhat depauperate relative to that of the breakwaters. This condition is probably a result of historically poor water quality discharges from the canneries and treatment plant and should improve as the harbor water quality improves. Since biomass and productivity of this community are unquantified, estimates of any losses or gains would be especially speculative.

Once the proposed dike is close to completion, the dike and semi-enclosed expanse of water should attract an increased abundance and

diversity of water-associated birds. As the water quality deteriorates, water area becomes land, and human disturbance increases, the fill area would lose this short-lived benefit. Should the margins of the completed fill area stay free of human disturbance, they should retain moderate bird roosting activities, especially along the more sheltered eastern side.

The proposed fill configuration should not interfere with the tidally induced, large central gyre of water in the outer harbor. Concern for the integrity of this gyre is necessary because it is thought to be responsible for maintaining good water quality in the outer harbor.

In summary, the proposed fill will reduce the harbor standing stock biomass by more than 150 tons, and all future growth that might have been supported by that biomass. Total fish and water-associated bird abundances would decline in the harbor because the fill would reduce the carrying capacity of the harbor ecosystem. Harbor and offshore populations of adult fishes will be adversely affected by the elimination of nursery grounds. A key feeding area for some birds (terns, cormorants, and pelicans) will be eliminated. Provided toxic contaminants were not a problem, ocean or inland disposal methods would cause negligible harm.

<u>The Terminal Island Treatment Plant Sewer Outfall</u>. The secondary treated sewage from the Terminal Island Treatment Plant (average capacity 30 mgd and present flows of about 15 mgd) is presently discharged 350 feet from shore in waters which are less than 17 feet deep and within the area of the proposed fill. Relocation of the outfall, at this time, is only necessary if the fill is constructed. The present outfall 'boil' does not seem to be a preferred resting or feeding area for either birds or fish. In that respect, its relocation offers neither positive or negative impacts. For fish, there is an area of avoidance around the existing outfall, as a result of the stress conditions in the plume, which would be recreated at the new site. In addition, the diversity of benthic organisms near the outfall terminus is low but improves rapidly away from the pipe as the plume dissipates away from the bottom. A similar condition would develop at the site of the relocated pipe.

Several relocation options have been considered; only the best and the worst, from an environmental perspective, will be mentioned herein. The worst relocation site would be at the northeast corner of the fill adjacent to the Seaplane Anchorage jetty. Model studies of harbor tidal currents have shown the inlet created between the landfill and Navy Mole to be an area of lesser water exchange. Sewage discharged in this corner would take much longer to dissipate and would degrade the entire

area, including the Seaplane Anchorage. The frequency of phytoplankton blooms and low dissolved oxygen conditions would be increased within the inlet.

The best location would be 1,000 feet south of the southern edge of the fill. This proposal has the additional adverse impacts of requiring 1,000 feet of new submarine pipeline construction; these impacts would include turbidity generated by a clamshell dredge used to dig the trench and bury the new pipeline, and temporary elimination of thousands of square meters of benthic community. By extending the new pipeline southerly, its discharge is placed directly into the main circulatory gyre of the outer harbor. This would improve the distribution of the nutrient laden freshwater sewage. The zone of avoidance and the area of benthic degradation should, therefore, be reduced in size while the likelihood of harmful accumulations of excess nutrients in other parts of the harbor (i.e. Seaplane Anchorage) would also be reduced.

The 'Mitigation Area'. The construction of this area would entail its own biological losses. At least 50 hectares of healthy, productive harbor benthos, containing about 100 metric tons of benthic organisms, would be lost by burial. The benthic community would begin redevelopment as soon as the deposition ceased, however. Because high quality sediment must be used for this open-water discharge, the grain size distribution should be coarser than the existing sediment in the 'mitigation area', which would result in a different faunal composition of the benthic community once it develops. Turbidity during open-water discharge could be widespread and significantly detrimental to primary productivity, bird and fish feeding, and fish health. Demersal fishes would be deprived of a good feeding area until the new benthos developed sufficiently. The new benthos would not likely support a greater biomass of fishes than before.

The creation of the 'mitigation area' should improve the fish nursery qualities of the area and replace some of those same qualities lost in the adjacent fill area. The 'mitigation area' should eventually provide excellent habitat for post-larval to sub-adult fishes of many species (e.g. croakers, queenfish, anchovy, flatfish, surfperches, blennies, gobies, and basses). This favorable habitat should develop by virtue of the nature of the design: shallow, sheltered waters, absence of noxious discharges into the area, adequate nutrient availability for phytoplankton growth, and adequate water quality. Turnover time of the water in the Seaplane Anchorage will probably be lengthened due to the greater isolation from the central tidal circulatory gyre and greater protection from winds which create currents. Upon completion, the actual bottom configuration of the area should resemble a series of irregular 'hummocks', with the shallowest portions about 8 feet below

mean lower low water and the deeper portions between 10 and 15 feet below MLLW.

This 'mitigation area' is not expected to support a greater abundance of adult demersal fishes than the area now supports. It should improve the area as a fish nursery. A better probability of recruiting young into the adult population has the potential to produce, but does not guarantee, stabilized or enhanced adult fish populations.

The abundant presence of juvenile fishes in the shallow waters of the 'mitigation area' should provide a favorable feeding environment for some birds (e.g. terns and cormorants). This would represent an improvement of this particular use of the area, which should replace some of the feeding area losses of the fill. That is, some of the bird feeding which would formerly have occurred in the proposed fill area, would now occur in the 'mitigation area' since it would be improved for those activities.

In summary, the 'mitigation area' would not replace the expected benthic or adult demersal fish community losses. Though construction of the 'mitigation area' would incur short-term losses of its own, fish nursery and bird feeding losses caused by the proposed fill would be partly replaced.

RECOMMENDATIONS

We recommend that this and future Corps of Engineers' Projects in San Pedro Bay (Los Angeles and Long Beach Harbors) include the conservation of fish and wildlife resources among the purposes for which the project is authorized.

Dredging.

1. Use the best available technology to conduct the dredging and pipeline relocations so as to reduce the impacts of suspended solids and contaminants.

2. Insure that the joints of the dredged material discharge line are properly sealed to prevent leaks or blowouts.

Disposal of Dredged Material.

1. Dispose of all uncontaminated dredged material by ocean disposal.

2. Dispose of contaminated dredged material at a suitable inland disposal site.

It is expected that this pair of recommendations will not be considered, so the following are proposed.

a) Reduce the area of the fill as much as possible. This could be accomplished by considering a combination of ocean disposal and fill in the harbor.

b) Isolate contaminated dredged material within the fill so that the possibility of reintroduction to the marine environment is eliminated.

c) Reorient the proposed fill configuration away from the shallow water but without interfering with the main circulatory gyre.

d) Employ the best available technology, to include silt screens and vertical discharge pipes, to reduce the quantity and distribution of suspended solids during discharges.

e) Construct the 'mitigation area' with high quality material.

f) Prevent suspended solids, generated by the 'mitigation area' construction, from entering the Seaplane Anchorage.

g) Construct the 'mitigation area' during the winter months when juvenile fish abundances are lowest.

h) Keep all disposal area discharges on the south side dike to preclude the spread of suspended solids into the 'mitigation area' and Seaplane Anchorage.

i) Improve water circulation in the western portion of the Seaplane Anchorage by creating an opening near the west end of the Seaplane Anchorage jetty.

j) Minimize the disturbance caused by activities of construction equipment in the Seaplane Anchorage.

k) Initiate, immediately, a biological study of the marine biota in the 'mitigation area' and Seaplane Anchorage. This study should be continued for at least two years after completion of the project. This would properly establish a baseline condition and permit monitoring the recovery of these important areas.

l) If the 'mitigation' feature fails, measures should be implemented to achieve equivalent mitigation.

m) Maintain coordination between the Corps of Engineers and fish and wildlife agencies throughout the term of the project to reduce detrimental impacts on fish and wildlife resources.

n) Provide fish and wildlife agencies funds to evaluate the mitigation features for fish and wildlife resources.

o) Provide during all construction phases, a strict enforcement monitoring program to insure that contractors are following your directives.

It is sincerely hoped that the marine environment of outer Los Angeles-Long Beach Harbors is recognized as a valuable and important resource which should not be needlessly degraded or destroyed. Continued massive filling, as manifested in this project, would surely result in the virtual elimination of this significant component of the marine ecosystem of the region.

With this planning aid letter, we have completed our work on this project for Fiscal Year 1979. The letter provides an assessment of data we collected or collated for the project as described above. Should you have specific questions on the content or recommendations, please contact Mr. Jack Fancher or myself at FTS 796-4270.

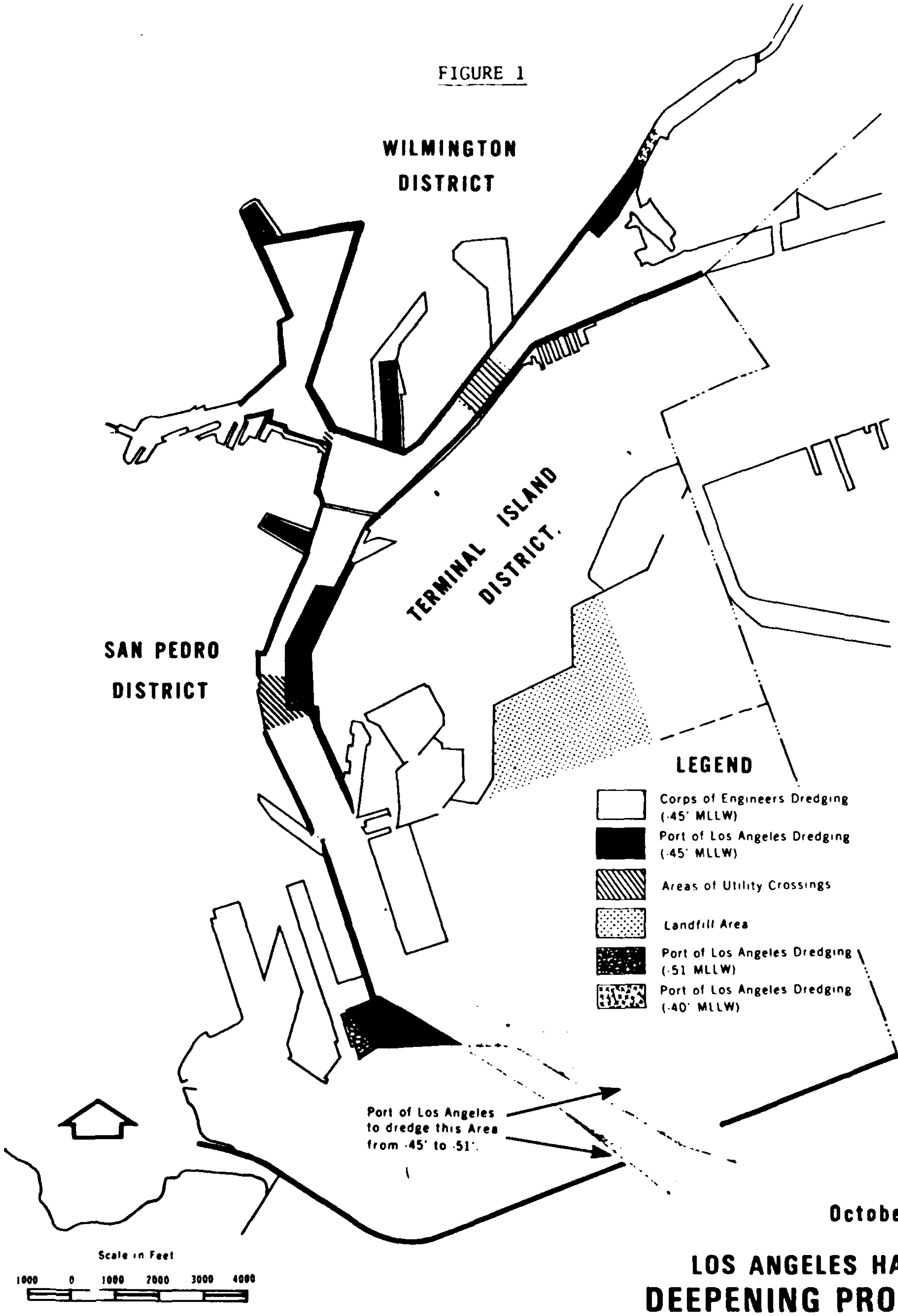
Sincerely yours,

Ralph C. Pisapia
Field Supervisor

JMF:gr
Enclosures

cc: NMFS, Terminal Island, CA
CDFG, Region 5, Long Beach, CA
S. Coast Regional Coastal Comm., Long Beach, CA
Regional Water Quality Control Bd., Los Angeles, CA
Port of Los Angeles, San Pedro, CA

FIGURE 1



October 1978

LOS ANGELES HARBOR
DEEPENING PROJECT

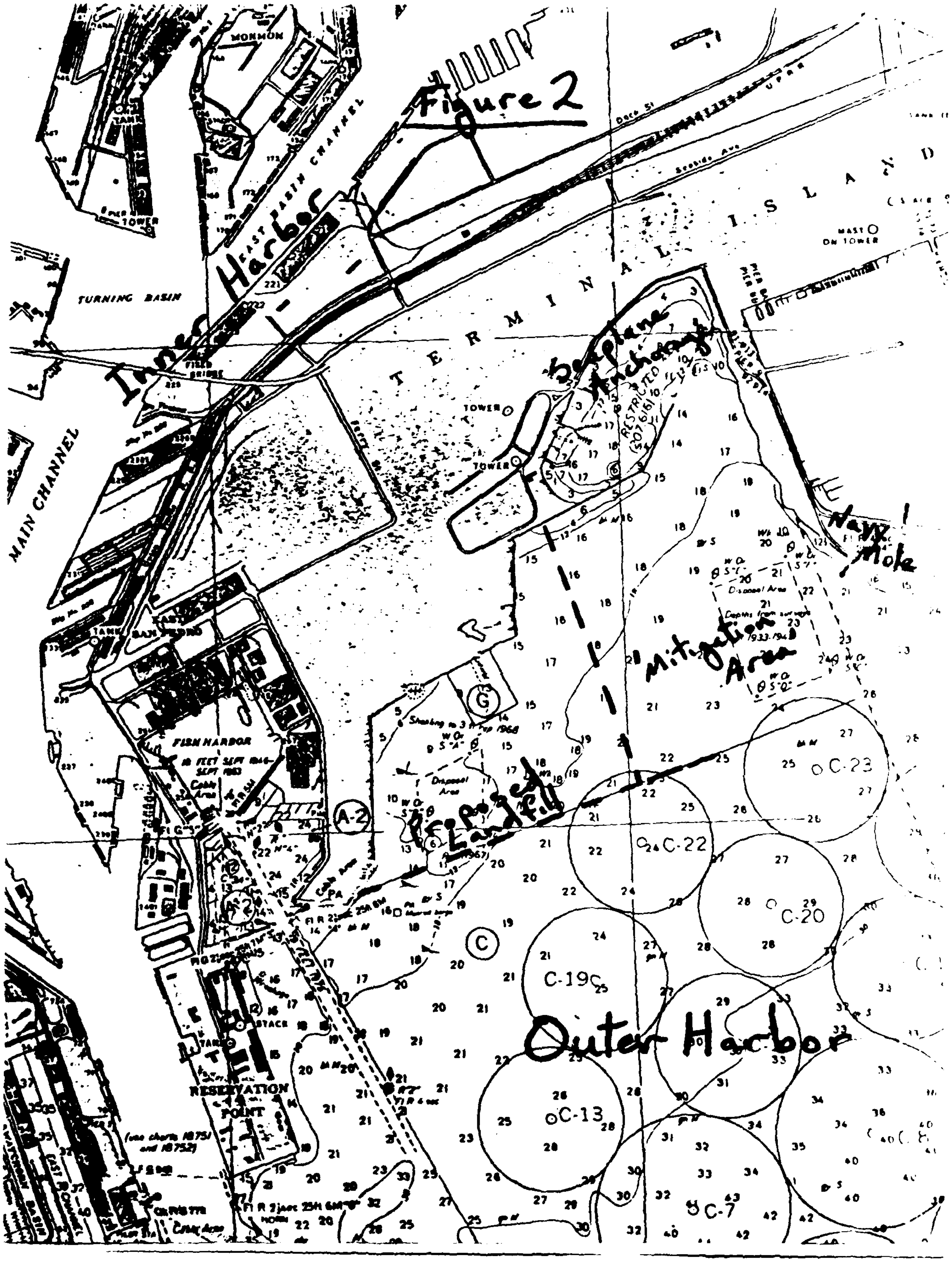


Figure 2
Inner Harbor
Seaplane Anchorage
Navy Mole
Mitigation Area
Proposed Landfill
Outer Harbor
TERMINAL ISLAND
MAIN CHANNEL
TURNING BASIN
EAST BASIN CHANNEL
MORMON
FISH HARBOR
SAN PEDRO
RESERVATION POINT
RESTRICTED (207.616)
Disposal Area
MAST ON TOWER
TOWER
A-2
C-23
C-22
C-20
C-19
C-13
C-7

TABLE 1

Fish Species From The Vicinity Of The Proposed Landfill, LA Harbor
August to November, 1978

Family Name	Common Name	Scientific Name
Sciaenidae	white croaker	Genyonemus lineatus
	queenfish	Seriphus politus
	yellowfin croaker	Umbrina roncador
	California corbina	Menticirrhus undulatus
Embiotocidae	shiner surfperch	Cymatogaster aggregata
	white surfperch	Phanerodon furcatus
	barred surfperch	Amphistichus argenteus
	black surfperch	Embiotoca jacksoni
	pile surfperch	Damalichthys vacca
	walleye surfperch	Hyperprosopon argenteum
Atherinidae	jacksmelt	Atherinopsis californiensis
	topsmelt	Atherinops affinis
Engraulidae	northern anchovy	Engraulis mordax
	deepbody anchovy	Anchoa compressa
Stromateidae	Pacific butterfish	Peprilus simillimus
Bothidae	California halibut	Paralichthys californicus
Pleuronectidae	hornyhead turbot	Pleuronichthys verticalis
	diamond turbot	Hypsopsetta guttulata
Cynoglossidae	California tonguefish	Symphurus atricauda
Serranidae	barred sand bass	Paralabrax nebulifer
Batrachoididae	specklefin midshipman	Porichthys myriaster
Synodontidae	California lizardfish	Synodus lucioceps
Myliobatidae	bat ray	Myliobatis californica
Carcharinidae	brown smoothhound	Mustelus henlei
	gray smoothhound	Mustelus californicus
	leopard shark	Triakis semifasciata
Cottidae	staghorn sculpin	Leptocottus armatus
Sphyraenidae	California barracuda	Sphyraena argentea
Syngnathidae	bay pipefish	Syngnathus leptorhynchus
Scombridae	Pacific bonito	Sarda chiliensis

TABLE 2

Fish Sampling In The Vicinity Of The Proposed Landfill, LA Harbor*
August to November, 1978

Otter Trawls
10 trawls

Common Name	Number Caught	Weight (g)	Rank by Abundance	% Composition by Abundance	Rank by Weight	% Composition by Weight
white croaker	554	30771	3	17.3%	1	49.1%
queenfish	1058	7649	2	32.9	2	12.2
white surfperch	88	7003	4	2.7	3	11.2
California halibut	21	5525	7	0.7	4	8.8
N. anchovy	1323	3877	1	41.2	5	6.2
bat ray	3	2500	12	0.1	6	4.0
diamond turbot	3	1315	12	0.1	7	2.1
shiner surfperch	59	857	6	1.8	8	1.4
hornyhead turbot	5	790	10	0.1	9	1.3
black surfperch	3	740	12	0.1	10	1.2
Pacific butterfish	61	580	5	1.9	11	0.9
California tonguefish	16	517	8	0.5	12	0.8
walleye surfperch	4	320	11	0.1	13	0.5
barred sandbass	3	160	12	0.1	14	0.2
deepbody anchovy	8	37	9	0.2	15	0.1
bay pipefish	1	3	13	0.1	16	0.1
	3210	62644g				

16 species   8.2 species/trawl   321 individuals/trawl   6.26 kilograms/trawl

average area swept $2340m^2$ average weight 19.5 grams/fish

*Trawls were taken from within the proposed landfill, Seaplane Anchorage, and adjacent to the Navy Mole in the mitigation area.

TABLE 3

Fish Sampling In The Vicinity Of The Proposed Landfill, LA Harbor
August to November, 1978

Gill Nets*
64.3 hr.

Common Name	Number Caught	Weight (g)	Rank by Abundance	% Composition by Abundance	Rank by Weight	% Composition by Weight
jacksmelt	77	18755	1	26.0%	1	19.5%
bat ray	14	11555	6	4.7	2	12.0
California corbina	19	10060	5	6.4	3	10.5
brown smoothhound	4	8870	10	1.3	4	9.2
Pacific bonito	8	7800	7	2.7	5	8.1
pile surfperch	19	6520	5	6.4	6	6.8
leopard shark	3	6425	11	1.0	7	6.7
queenfish	45	5110	3	15.2	8	5.3
white croaker	47	4850	2	15.9	9	5.0
gray smoothhound	5	4750	9	1.7	10	4.9
California barracuda	6	4100	8	2.0	11	4.3
white surfperch	20	1590	4	6.7	12	1.7
barred surfperch	3	1340	11	1.0	13	1.4
barred sandbass	2	940	12	0.7	14	1.0
diamond turbot	3	685	11	1.0	15	0.7
lizardfish	2	500	12	0.7	16	0.5
yellowfin croaker	3	455	11	1.0	17	0.5
black surfperch	2	440	12	0.7	18	0.5
California halibut	2	400	12	0.7	19	0.4
specklefin midshipman	2	370	12	0.7	20	0.4
hornyhead turbot	2	310	12	0.7	21	0.3
staghorn sculpin	1	95	13	0.4	22	0.1
N. anchovy	2	70	12	0.7	23	0.1
topsmelt	1	40	13	0.4	24	0.1
shiner surfperch	4	21	10	1.3	25	0.1
	296	96501				

25 species average weight 324 grams/fish

*Net dimensions 37.5m x 1.8m, 5 panels with mesh lengths between 1.3cm and 8.9cm. The nets were set for 3 to 4 hours at a time, usually close to shore within the proposed landfill and the mitigation area.

TABLE 4

Birds Observed In The Vicinity
Of The Proposed Fill In 1978*

Common Name	Scientific Name
Surf scoter	Melanitta perspicillata
Double-crested cormorant	Phalacrocorax auritus
Western gull	Larus occidentalis
Brown pelican	Pelecanus occidentalis
Eared grebe	Podiceps nigricollis
Sanderling	Calidris alba
Heerman's gull	Larus heermanni
Lesser scaup	Aythya affinis
Forster's tern	Sterna forsteri
Western grebe	Aechmophorus occidentalis
Cinnamon teal	Anas cyanoptera
Black-bellied plover	Pluvialis squatarola
Ruddy turnstone	Arenaria interpres
Willet	Catoptrophorus semipalmatus
California gull	Larus californicus
Spotted sandpiper	Actitis macularia
Bonaparte's gull	Larus philadelphia
Herring gull	Larus argentatus
Wandering tattler	Heteroscelus incanum
Pelagic cormorant	Phalacrocorax pelagicus
Red-throated loon	Gavia stellata
Surfbird	Aphriza virgata
Ring-billed gull	Larus delawarensis
Black turnstone	Arenaria melanocephala
Whimbrel	Numenius phaepus
Brandt's cormorant	Phalacrocorax penicillatus
Common loon	Gavia immer
California least tern	Sterna albifrons
Elegant tern	Thalasseus elegans
Glaucous-winged gull	Larus glaucescens
Snowy plover	Charadrius alexandrinus
Canvasback	Aythya valisineria
Great blue heron	Ardea herodias
Green-winged teal	Anas carolinensis
Killdeer	Charadrius vociferus
Western sandpiper	Ereunetes mauri
White-winged scoter	Melanitta deglandi
Common scoter	Melanitta nigra
Belted kingfisher	Megaceryle alcyon
Long-billed dowitcher	Limnodromus scolopaceus
Arctic loon	Gavia arctica
Caspian tern	Hydroprogne caspia
Parasitic jaeger	Stercorarius parasiticus

*The species are arranged approximately from most abundant to least abundant, on a yearly basis. Observations by FWS, HEP, and CDFG.

DEPARTMENT OF THE ARMY
LOS ANGELES DISTRICT, CORPS OF ENGINEERS
P. O. BOX 2711
LOS ANGELES, CALIFORNIA 90053

SPLED-EP

3 August 1979

Mr. Ralph C. Pisapia
Field Supervisor
U.S. Fish and Wildlife Service
Ecological Services
24000 Avila Road
Laguna Niguel, California 92677

Dear Mr. Pisapia:

This letter is in response to your planning-aid letter on the Los Angeles Harbor Deepening Project, dated 29 June 1979. Throughout this project, the US Army Corps of Engineers and the wildlife agencies have maintained close coordination and worked together to improve the project. To this end, the purpose of this letter is to discuss the recommendations contained in the planning-aid letter and to clarify some points of misunderstanding.

Because our Supplemental Environmental Impact Statement (SEIS) on this project will not be transmitted to Congress, the Corps will not request a Fish and Wildlife Coordination Act Report to accompany this SEIS.

The figures presented in the description of the project should be modified. The project will take approximately 30 months to complete, which includes 27 months for dredging and 15 months for the dike construction. The landfill and mitigation area will be 190 acres each, composed of 9.7 million cubic yards of Corps dredged material and 5.0 million cubic yards of port dredged material. Total cost of the dredging and fill is expected to be $65 million, which includes $26 million for Corps dredging, $14.8 million in port dredging, $10.2 million in utility removals and relocations, and $13 million for dike construction.

It appears, from the discussion on the impacts of the fill, that there are some misconceptions on how the dike will be constructed. The dike and fill will be constructed in lifts which will allow the free flow of water back into the adjacent harbor waters. This will allow fish to return to open water.

Many of the recommendations of the Fish and Wildlife Service contained in the planning-aid letter reemphasize points that have been brought up

in discussions through the life of the project. While the recommendations are of help to the Corps, it must be recognized that the Los Angeles Harbor Deepening Project is now in an advanced stage and is nearing completion from a planning point of view.

Disposal of the dredged material in deep water or on land was considered during the earlier stages of this project. In authorizing the project, Congress had the option to authorize further study, or to authorize construction. Based on the material contained in the Final EIS and Interim Project Report, Congress elected to authorize prosecution of the project as defined in House Document 94-594. As a result of this authorization, no further alternative studies were made. Also, as a result of the authorization, the size and location of the fill, except for minor modifications, will remain the same.

The Corps will use the best available technology and careful monitoring of the dredging contractor to insure a minimum disturbance of the area by the resuspension of sediments, particularly into the mitigation area and seaplane anchorage.

A number of factors, including the circulatory gyre, were considered in determining the final location of the fill. Any movement of the fill away from the gyre will cause conflicts with other interests, including recreational boating, fish and wildlife resources and water circulation and tidal flushing concerns. Model studies indicated the present site to have a negligible impact on the tidal circulation in the harbor.

The Corps of Engineers does not normally dictate a dredging schedule to a contractor. In the case of the mitigation area, the material will come from the area near the main entrance to the harbor in relatively open water. Inclement weather might not permit that dredging take place during the winter months. The recommendation to construct the mitigation area in the winter months will be considered during preparation of plans and specifications but there is no guarantee that implementation will be possible. The mitigation will most likely be the last area to be constructed and, therefore, will remain unaffected by the dike and fill construction.

Model studies have demonstrated a slight improvement in the circulation of the seaplane anchorage area as a result of the placement of the fill and dike. An opening in the west end of the seaplane anchorage breakwater would result in the movement of sand from the mitigation area into the anchorage by wave action. This movement would be detrimental to both the mitigation area and the seaplane anchorage.

There is no basis for assuming at this time that the mitigation area would not reestablish to at least present levels. If a severe problem

SPLED-EP 3 August 1979
Mr. Ralph C. Pisapia

should occur, it may require a post authorization study. At the present time, it is not the policy of the Corps of Engineers to transfer operation and maintenance funds to other agencies to perform monitoring. Monitoring of the recovery of the mitigation area, should it appear to be necessary, could be done by the Corps or the Port. The advantages of such monitoring are being considered and discussed with the Port.

The Corps is in agreement that the project will have a significant adverse effect on the marine ecosystem of the harbor in the immediate area of the fill, although we do not agree with all the statements in the planning-aid letter. The Corps also agrees that the harbor contains valuable fish and wildlife resources that should be considered and protected to the extent possible while planning for competing activities within the harbor. It is recognized that any future landfills should be carefully analyzed to avoid the piecemeal loss of the resources.

The Corps of Engineers has funded the U.S. Fish and Wildlife Service substantially to provide assistance for this project. A great deal of time and effort by several agencies went into defining the mitigation plan. It is hoped that the Corps and the Fish and Wildlife Service can continue to cooperate to minimize environmental impacts while balancing competing concerns.

Sincerely,

Gwynn A. Teague
GWYNN A. TEAGUE
Colonel, CE
District Engineer

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southwest Region
300 South Ferry Street
Terminal Island, California 90731

December 14, 1977 FSW33/JJS

Colonel Hugh G. Robinson
District Engineer
Los Angeles District, Corps of Engineers
P.O. Box 2711
Los Angeles, California 90053

Dear Colonel Robinson:

Subject: Corps of Engineers Navigation Improvement Project, Los Angeles Harbor

We have reviewed the material presented in the public information brochure which was circulated on November 23, 1977. Our major concern with the project as planned is the irreparable damage to marine habitat which will result from the proposed extensive land fill.

Throughout the text of the informational brochure the fill is described as being only 187 acres, yet on Plate 2 of that same document it appears that the decision has recently been made to expand the size of the fill to 282 acres. Furthermore, there is no mention in the text of the need for the land fill, though quite a bit of data are included justifying the dredging portion of the project.

It is also unclear whether the fill is an integral part of the overall Corps project therefore requiring compensation by the Corps for resulting environmental damage, or whether compensation for the fill will be the responsibility of the Port of Los Angeles.

We would suggest that before further action is taken on the project, these points be clarified and a suitable package of mitigation and compensation be developed in consultation with the National Marine Fisheries Service and other concerned resource agencies.

Mr. James Slawson of my staff will be available to discuss this matter. He may be reached at our letterhead address or phone (213) 548-2575. We would also appreciate receiving one copy of the October 1974, "Final Environmental Impact Study" for the project.

Sincerely,

Gerald V. Howard
Regional Director

cc: James McKevitt, USFWS, Laguna Niguel
Rolf Mall, CDF&G, Long Beach

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southwest Region
300 South Ferry Street
Terminal Island, California 90731

February 13, 1978 FSW33/JJS

Colonel Hugh G. Robinson
District Engineer
Los Angeles District, Corps of Engineers
P.O. Box 2711
Los Angeles, California 90053

Dear Colonel Robinson:

Subject: Corps of Engineers Navigation Improvement Project, Los Angeles Harbor - Public Announcement dated 6 February 1978.

The proposed relocation of the Los Angeles Harbor landfill of 200 acres as presented in the subject Announcement does nothing to alleviate the concerns we stated in our December 14, 1977 letter to you. The irreparable damages to the marine habitat resulting from the placement of the fill will merely be transferred from one site to another and will still require compensation.

We recognize that the technical responsibility for compensating the environmental impacts of the fill lies with the Port of Los Angeles. However, we are also aware that if the placement of the fill is their responsibility, then it will require a permit from your office subject to Section 404 of the Federal Water Pollution Control Act Amendments of 1972.

Because of the direct regulatory role your agency will have in this process we maintain that before further action is taken on the project, a suitable package of mitigation and compensation be developed through your office in consultation with the National Marine Fisheries Service, the Port of Los Angeles, and other concerned resource agencies.

We look forward to hearing from you on this matter.

Sincerely,

Gerald V. Howard
Regional Director

DISTRICT OFFICE
SUITE 202
700 SOUTH GRAND AVENUE
SAN PEDRO 90731
TELEPHONE: 832-4234

SACRAMENTO OFFICE
ROOM 3132
STATE CAPITOL 95814
TELEPHONE 445-7906

EVE OSTOJA, CONSULTANT
HELEN TRAINOR,
COMMITTEE SECRETARY

Assembly
California Legislature

Assistant Speaker pro Tempore
and
Dean of the Assembly

VINCENT THOMAS
MEMBER OF ASSEMBLY, FIFTY-SECOND DISTRICT

COMMITTEES
CHAIRMAN, INTERGOVERNMENTAL RELATIONS
HUMAN RESOURCES
LABOR, EMPLOYMENT AND CONSUMER AFFAIRS

MEMBER, PACIFIC MARINE FISHERIES COMMISSION APPOINTED BY THE GOVERNOR

November 17, 1977

Lt. Col. Robert H. Reinen
Deputy District Engineer
Los Angeles District Corps of Engineers
Box 2711
Los Angeles, California 90053

Dear Col. Reinen:

This letter concerns your public hearing to be held on November 30 at 7:30 P.M. at the American President Lines terminal in San Pedro.

The recreational boating people have long complained about the lack of adequate facilities and slip capacity in Los Angeles Harbor and, in fact, there has been a diminution of slips in the Harbor over the past several years.

We now observe the partial filling of Reeves Field, an irreplaceable harbor with dredge spoils when there are hundreds of acres of subsidence areas in the Los Angeles/Long Beach Harbor available and needing fill.

Certainly we need the dredging of Los Angeles Harbor to accommodate larger ships. Until a need to fill Reeves Field is demonstrated any required rock dikes to accept spoils can probably be situated in several other locations.

The Reeves Field area can accommodate in excess of 1,600 small craft. It would appear that something is wrong when Long Beach City is struggling to build a $20,000,000 marina for 1,600 small craft and Los Angeles Harbor is seeking to eliminate a potential 1,600 small craft marina available at a fraction of the $20,000,000 figure.

Sincerely,

Vincent Thomas

VINCENT THOMAS

VT:grf

ROOM 2086
STATE CAPITOL
SACRAMENTO 95814
(916) 445-6447

1611 SO. PACIFIC COAST HWY.
REDONDO BEACH 90277
(213) 540-1611

700 SO. GRAND AVENUE
SUITE 204
SAN PEDRO 90731
(213) 548-0651

COMMITTEES:
GOVERNMENTAL ORGANIZATION
INSURANCE AND FINANCIAL INSTITUTIONS
JUDICIARY
LOCAL GOVERNMENT

JOINT COMMITTEE ON
TORT LIABILITY
(VICE CHAIRMAN)

California State Senate

ROBERT G. BEVERLY
SENATOR
TWENTY-SEVENTH DISTRICT

December 8, 1977

Colonel G. Robinson
Los Angeles District Corps of Engineers
Post Office Box 2711
Los Angeles, California 90053

Dear Colonel Robinson:

It has come to my attention that the Army Corps of Engineers is in the process of undertaking a channel deepening and harbor dredging project in Los Angeles Harbor.

I am in full accord with the proposal to improve the navigation channels in Los Angeles Harbor. However, I am opposed to any fill operations in the areas adjacent to Reeves Field. I would trust that such areas could ultimately be used for recreational boating needs.

Sincerely,

ROBERT G. BEVERLY

RGB:kmb

cc: Fred B. Crawford, General Manager
Port of Los Angeles

OFFICE OF THE SECRETARY
RESOURCES BUILDING
1416 NINTH STREET
95814

(916) 445-5656

Department of Conservation
Department of Fish and Game
Department of Forestry
Department of Navigation and Ocean Development
Department of Parks and Recreation
Department of Water Resources

EDMUND G. BROWN JR.
GOVERNOR OF
CALIFORNIA

Air Resources Board
California Coastal Commission
California Conservation Corps
Colorado River Board
Energy Resources Conservation and Development Commission
Regional Water Quality Control Boar
San Francisco Bay Conservation and Development Commission
Solid Waste Management Board
State Coastal Conservancy
State Lands Commission
State Reclamation Board
State Water Resources Control Board

THE RESOURCES AGENCY OF CALIFORNIA
SACRAMENTO, CALIFORNIA

APR 4 1978

Colonel Hugh G. Robinson
District Engineer
Los Angeles District
U. S. Army Corps of Engineers
P. O. Box 2711
Los Angeles, CA 90053

Dear Colonel Robinson:

The State agencies listed below have reviewed your public announcement of February 6, 1978, concerning the proposed Los Angeles Harbor Landfill and have the following comments.

We recommend that the Corps of Engineers hold its proposed Los Angeles Harbor deepening plans in abeyance and withhold its permit for the proposed landfill project until suitable mitigation and compensation measures have been developed.

This proposal represents a reduction in area and a change in location of an earlier plan. The Department of Fish and Game stated its concerns regarding that earlier plan at a public meeting on December 12, 1977 (copy attached). Our main concerns at that time were for the loss of marine habitat and feeding area for the California least tern, an endangered species. In our opinion, these concerns remain valid.

The proposed project would destroy 200 acres of soft bottom benthic habitat, about 3,000 acre-feet of water column, and approximately 6,500 feet of shoreline habitat, while creating about 7,700 feet of new shoreline habitat. The following table, developed from the attached map, illustrates some effects of the project:

	Acres of open water and soft bottom habitat	Acres of open water - least tern essential habitat	Shoreline area linear feet
Without project	639 acres	595 acres	14,106 feet
With project	439 acres	428 acres	15,243 feet
Net change	-200 acres	-167 acres	+1,137 feet
Percent change	- 31	- 28	+ 8

The essential habitat for the California least tern, identified by the Least Tern Recovery Team, has recently been recommended for classification as critical habitat under the Endangered Species Act of 1973.

The proposed landfill is in the outer harbor area where there are recreationally important sport fisheries, economically important commercial fisheries, and assemblages of plants and animals that are otherwise valuable.

Since the Corps recently stated that it has no authority to participate in any mitigation for this project, we believe that the Port of Los Angeles should provide mitigation and/or compensation for project-induced impacts to marine and California least tern habitat. We propose the following mitigation and compensation measures to alleviate impacts of the proposed landfill.

1. Acquire and/or dedicate the Terminal Island nesting site which the California least tern used during 1977, as a California least tern nesting area. Provide funds for the administration and protection of this area by either a State or federal resource agency. This would assure the continued existence of a known nesting area and would mitigate for the loss of approximately 28 percent of essential feeding area.

2. Enhance, acquire, and/or dedicate an area at least equivalent in perceived value to that lost as a result of the proposed landfill. We believe a site adjacent to the San Pedro breakwater would be appropriate. Kelp restoration activities are presently being undertaken in this area as mitigation for other project impacts.

No properties currently included in or eligible for inclusion in the National Register of Historic Places, the California State Historical Landmarks, or the California Points of Historical Interest listings appear to be within the project's area of potential environmental impact. Since our records are not as current as those of the Archeological Regional Officer for this area, however, we recommend that the Corps conduct a Cultural Resources Assessment Program to identify and assess all cultural properties within the impact area of this proposed landfill.

The Department of Navigation and Ocean Development, the Los Angeles Regional Water Quality Control Board, and the State Lands Division have commented directly to the Corps. Their remarks should be considered an integral part of the State's response.

Thank you for the opportunity to comment on this project.

Sincerely,

L. FRANK GOODSON
Assistant Secretary for Resources

Attachments

cc: Department of Navigation and
Ocean Development
Department of Parks and Recreation
State Water Resources Control Board
Department of Fish and Game
Wildlife Conservation Board
Department of Water Resources
Department of Conservation
State Lands Division
California Coastal Commission
Bureau of Sport Fisheries
and Wildlife
Mr. Gerald V. Howard
Applicant - U. S. Army Corps of Engineers

STATEMENT PRESENTED AT PUBLIC MEETING FOR
NAVIGATIONAL IMPROVEMENT OF LOS ANGELES HARBOR
SAN PEDRO, CALIFORNIA

12 December 1977

by
Rolf E. Mall
Environmental Services Supervisor

Colonel Robinson, Mr. Crawford, Ladies and Gentlemen, I am Rolf Mall, and I am here on behalf of the Marine Resources Region of the California Department of Fish and Game.

The Department has considerable interest in activities conducted within the harbor complex shared by the Port of Los Angeles and the Port of Long Beach and we are interested for two different kinds of reasons.

On the one hand, we recognize the appropriateness of continued maintenance and development of necessary port facilities, since from our view such efforts tend to reduce development pressures, and the often associated adverse impacts upon fish and wildlife resources and their habitat, in other areas of California. On the other hand, the harbor itself provides important habitat for many living resources and the Department has responsibilities for maintaining those resources. We are particularly interested therefore in the land filling operation associated with the improvement project in terms of adverse effects that might occur as a result of loss of habitat, loss of resource use opportunities and reductions in harbor water quality occurring from circulation pattern modifications. These concerns focus on the outer harbor area where there are recreationally important sportsfisheries and economically important commercial fisheries, as well as assemblages of plants and animals that are otherwise valuable.

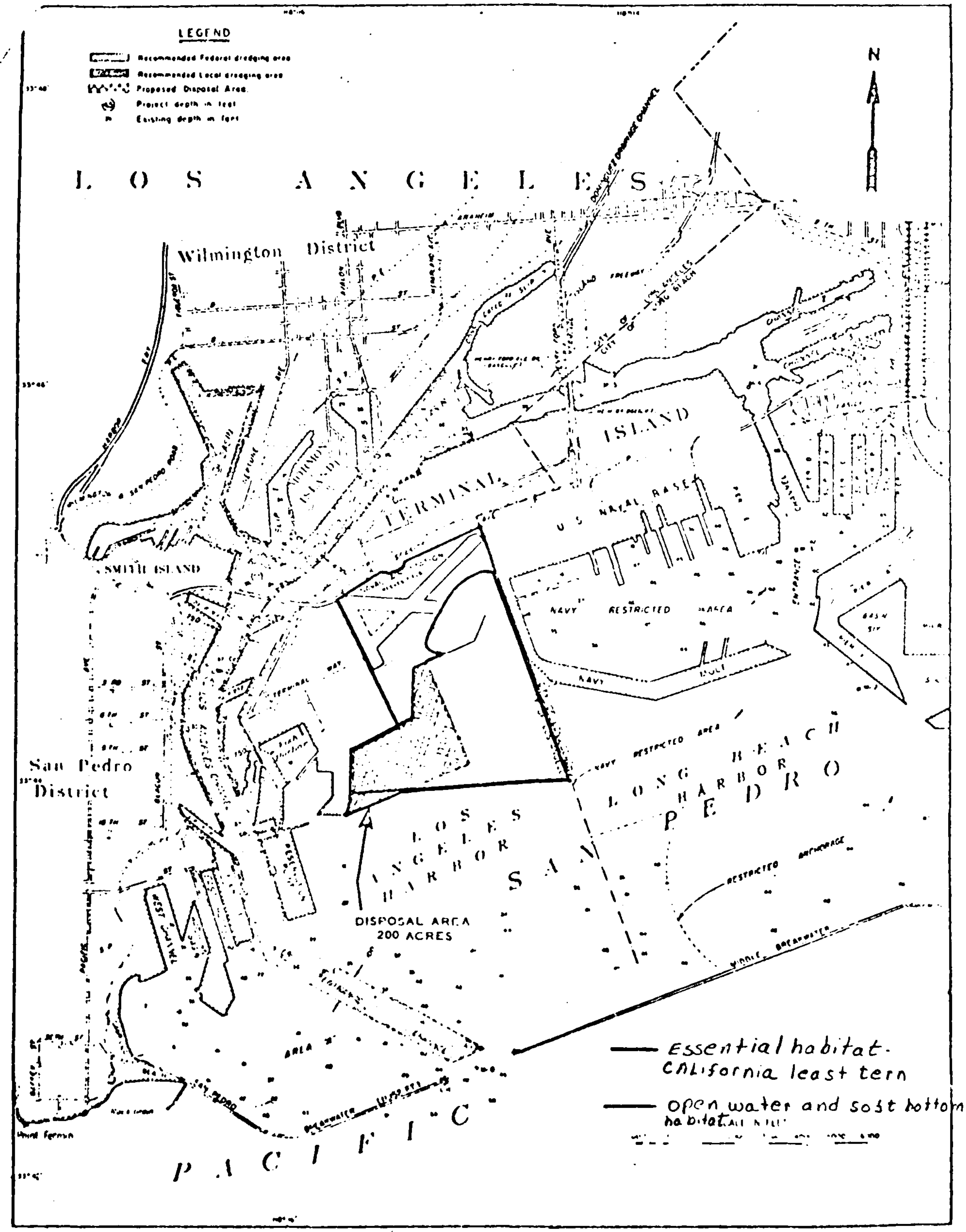
In that later regard we have particular concern for the loss of water column and soft-bottom habitat area, that would result from filling

operations involving an area approximately 200 or 300 acres in extent. We must point out that part of that site is an important feeding area for the endangered California least tern which has nested at various locations on Terminal Island in recent years. During 1977, 85 pairs nested on Reeves Field with excellent success, and represented approximately 15% of the total California nesting activity by least terns.

A combination of suitable nesting sites and available food of appropriate size and abundance is critical to the continued existence of that animal. The deposition of fill, in the area delineated in the Corps public information brochure, particularly on plate 2, could have a significant detrimental effect on the availability of small fish used by least terns as a food source through displacement and alteration of the aquatic habitat types necessary for viable and available populations of such fishes. Consideration should be given, therefore, to alternative fill configurations or spoil sites that would eliminate or minimize such adverse effects, unless it can be satisfactorily demonstrated that such effects would not occur.

As a final thought, we urge that the Port of Los Angeles' most recent overall landfill development proposals be circulated for review and comment before the Corps' project is finalized. We would find it valuable to consider our concerns and ways to mitigate them in relation to such overall planning efforts.

We would be pleased to meet with respective staffs of the Port of Los Angeles, the Corps of Engineers, and the federal conservation agencies in an effort to develop mutually acceptable mitigation and/or compensation measures that may be necessary to protect fish and wildlife resources.



LOS ANGELES HARBOR'S PLAN (FEBRUARY 1978)

INCL 1

STATE OF CALIFORNIA—RESOURCES AGENCY

EDMUND G. BROWN JR., Governor

DEPARTMENT OF NAVIGATION AND OCEAN DEVELOPMENT
1416 NINTH STREET
SACRAMENTO, CALIFORNIA 95814
(916) 445-6281

December 12, 1977

Colonel Hugh G. Robinson
District Engineer
Department of the Army
Los Angeles District, Corps of Engineers
P. O. Box 2711
Los Angeles, CA 90053

Dear Colonel Robinson:

Navigation Improvements Los Angeles
Harbor/General Design Memorandum

The Department of Navigation and Ocean Development opposes the use of the Reeves Field seaplane anchorage harbor for the disposal of dredge spoils. The Department believes that alternate development plans could be formulated which would accommodate small craft berthing in the Reeves Field basin and, at the same time, the expansion of the commercial operations of the Port.

The demand for small craft berthing along the Southern California coast, and particularly along the Los Angeles County coast, far exceeds the berthing space that is now available. The relative shortage in the County is the highest in the state. A recent inventory reveals that the number of berths available in Los Angeles County is 14,900, of which only 3,100 are located in Los Angeles Harbor.

It is estimated that there is a present day shortage of 6,000 berths in the County. The Reeves Field basin could accommodate up to 2,000 boats with minimum development and in a short time frame. The development of the Reeves Field basin for small craft berthing now would satisfy a large portion of the unmet needs and to that extent lessen pressures for the use of environmentally sensitive water elsewhere. The growing demand for berthing and the shrinking availability of alternate locations for small craft facilities heighten the need to preserve and fully utilize those areas, such as Reeves Field, that are natural for small craft use.

Past plans for small craft development within the harbor have suffered from opposition, inaction, and delay and failed, perhaps finally, due to cost escalation. The existence of the inner breakwater at Reeves Field would mean that costs for small craft facilities there would be well within reason and financial feasibility.

The Department feels that Reeves Field should be dedicated to help meet the needs for small craft facilities and accommodate the public rights of navigation. Therefore, the Department objects to plans under which dredge spoils would be deposited in the Reeves Field basin.

Sincerely,

Marty Mercado

MARTY MERCADO
Director

RESOLUTION OF THE NAVIGATION AND OCEAN DEVELOPMENT COMMISSION
STATE OF CALIFORNIA

RE: REEVES FIELD AREA, LOS ANGELES HARBOR

WHEREAS, the Port of Los Angeles has, for the past 35 years continuously promised to accommodate the needs of recreational boating in accordance with the legislative grant of Los Angeles Harbor as administered by the State Lands Commission; and

WHEREAS, the Port of Los Angeles has not provided additional boating facilities; and

WHEREAS, there has been a reduction in the total number of recreational boating slips available due to the apparent policy of the Port of Los Angeles to favor commercial shipping to the exclusion of recreational boating; and

WHEREAS, it is our understanding that the United States Army, Corps of Engineers, did, in 1970, designate the Reeves Field Harbor area as "open" on their harbor model plan with the understanding that it would be used for recreational boating; and

WHEREAS, it is our further understanding that the Corps of Engineers guaranteed that prior to any other use, recreational boating needs would be met within the harbor plan; and

WHEREAS, Reeves Field Harbor is an existing harbor developed by the U. S. Navy and has been relinquished to the Port of Los Angeles to be utilized in accordance with the spirit of the guidelines set down by the Federal Environmental Protection Agency and the California Coastal Zone Act; and

WHEREAS, the Navigation and Ocean Development Commission did recognize the need for additional boating facilities in the Los Angeles Harbor and the potential of the Reeves Field basin for this purpose, passing a resolution to that effect in 1976.

NOW, THEREFORE, Be it Resolved that the Navigation and Ocean Development Commission reaffirms the concerns it expressed in the resolution of 1976; and

BE IT FURTHER RESOLVED that the Navigation and Ocean Development Commission strongly opposes the use of Reeves Field Harbor waterways, also known as the Seaplane Anchorage area, as a depository for Los Angeles Harbor dredge spoils; and

BE IT FURTHER RESOLVED that it is recommended that the U. S. Army, Corps of Engineers, require the Port of Los Angeles to properly provide for recreational boating needs prior to the approval of any dredge spoil disposal plan.

WALTER B. MILES, Chairman
Navigation and Ocean Development Commission

I, Marty Mercado, Secretary of the Navigation and Ocean Development Commission, do hereby certify that the foregoing is a full, true, and correct copy of a resolution adopted by the Navigation and Ocean Development Commission at a meeting held at Emeryville, California, on December 2, 1977.

Marty Mercado

MARTY MERCADO, Secretary
Navigation and Ocean Development Commission

December 2, 1977

STATE OF CALIFORNIA

RE: DEVELOPMENT OF THE REEVES FIELD AREA OF LOS ANGELES HARBOR AS A SMALL CRAFT HARBOR

WHEREAS, the demand for berthing in the Los Angeles-Long Beach area of California far exceeds the number of available berths at the existing small craft harbors in that part of the State; and

WHEREAS, the number of sites available for the development of small craft harbors in Southern California is severely limited; and

WHEREAS, there exists the potential within Los Angeles Harbor for the development of new small craft harbors; and

WHEREAS, in that tract of Los Angeles Harbor known as Reeves Field, there exists the potential for development of such a harbor with a capability of berthing more than one thousand recreational and commercial small watercraft; and

WHEREAS, to this date, the development of other sites suitable for such harbors within Los Angeles Harbor (Fish Harbor and Cabrillo Beach) has failed to materialize; and

WHEREAS, the construction costs of a small craft harbor at Reeves Field would be comparatively minimal due to existing breakwaters which form the Reeves Field Basin; and

WHEREAS, there exists an option to allow continued use of the existing Reeves Field Basin for small watercraft; and

WHEREAS, it is currently being planned to fill in the Reeves Field basin; and

WHEREAS, our concerns and the concern of others for the protection of valuable coastal environmental resources will affect the potential ability to develop new boating facilities in the future, and the use of the existing basin at Reeves Field as a small craft harbor will lessen the pressures for use of environmentally sensitive water areas

NOW, THEREFORE, Be It Resolved that the Navigation and Ocean Development Commission opposes any development of the Reeves Field area of Los Angeles Harbor for any purpose which would eliminate the possibility of that area being used by small recreational and commercial watercraft; and

BE IT FURTHER RESOLVED that the Navigation and Ocean Development Commission encourages the development of the Reeves Field area for use as a small craft harbor; and

BE IT FURTHER RESOLVED that copies of this resolution be sent to the Los Angeles Harbor Commission, the United States Corps of Engineers, the Los Angeles City Council, and all public officials who have authority or responsibility in this area.

Stanley B. Williams

STANLEY B. WILLIAMS, Chairman
NAVIGATION AND OCEAN DEVELOPMENT COMMISSION

I, Marty Mercado, Secretary of the Navigation and Ocean Development Commission, do hereby certify that the foregoing is a full, true, and correct copy of a resolution adopted by the Navigation and Ocean Development Commission at a meeting held at Eureka, California, on July 9, 1976.

MARTY MERCADO, Secretary
NAVIGATION AND OCEAN DEVELOPMENT COMMISSION

Dated: July 9, 1976

STATE OF CALIFORNIA—RESOURCES AGENCY

EDMUND G. BROWN JR., Governor

DEPARTMENT OF NAVIGATION AND OCEAN DEVELOPMENT
1416 NINTH STREET
SACRAMENTO, CALIFORNIA 95814
(916) 445-6281

February 17, 1978

Hugh G. Robinson
Colonel, CE
District Engineer
Los Angeles District,
Corps of Engineers
P. O. Box 2711
Los Angeles, CA 90053

Dear Colonel Robinson:

Proposed Los Angeles Landfill

The Department of Navigation and Ocean Development has no comment on the new proposed landfill site except to indicate that it is definitely a preferable alternative to the filling of the seaplane anchorage, adjacent to Reeves Field. As we have indicated previously, the seaplane anchorage could be developed as a small craft marina without the dredging and filling costs normally associated with such facilities. We encourage the Port of Los Angeles to proceed with plans for recreational boat berthing at the anchorage site, as a project at this location will help alleviate the severe shortage of facilities that exists in the Los Angeles-Long Beach area.

Thank you for the opportunity to comment on this matter.

Sincerely,

Marty Mercado

MARTY MERCADO
Director

cc: Mr. Bill Satow
Facilities Division

STATE OF CALIFORNIA

EDMUND G. BROWN JR., Governor

CALIFORNIA COASTAL COMMISSION
1540 MARKET STREET, 2nd FLOOR
SAN FRANCISCO, CALIFORNIA 94102
PHONE: (415) 557-1001

November 22, 1977

Department of the Army
Los Angeles District
Corps of Engineers
P. O. Box 2711
Los Angeles, CA 90053

Subject: Public Meeting on Navigation Improvements for Los Angeles Harbor

Gentlemen:

In response to your public notice dated October 27, 1977, this letter outlines the planning responsibilities of the California Coastal Commission and the Port of Los Angeles as they may affect the Corps' proposed dredging and filling project.

Under provisions of the California Coastal Act of 1976 (Public Resources Code Section 30000), the Port of Los Angeles is required to submit a master plan for certification by the Coastal Commission. This plan must include (1) the proposed uses of land and water areas, (2) the projected design and location of port land and water areas, berthing and navigation ways and systems, (3) estimates of the effects of development on habitat areas and the marine environment with proposals to minimize and mitigate substantial adverse impacts and (4) provisions for public participation in the planning process.

The California Legislature, in enacting a special chapter of the Coastal Act for port planning and development, has recognized that the ports of the State constitute important economic resources and are an essential element of the national maritime industry.

It is our understanding that the proposed Federal project would require dredging of about 10,000,000 cubic yards of spoil material and creation of 187 acres of new land adjacent to Terminal Island. The following Coastal Act policies are applicable to such dredging and filling activities:

Section 30705 states:

30705. (a) Water areas may be diked, filled, or dredged when consistent with a certified port master plan only for the following:

(1) Such construction, deepening, widening, lengthening, or maintenance of ship channel approaches, ship channels, turning basins, berthing areas, and facilities as are required for the safety and the accommodation of commerce and vessels to be served by port facilities.

(2) New or expanded facilities or waterfront land for port-related facilities.

(3) New or expanded commercial fishing facilities or recreational boating facilities.

(4) Incidental public service purposes, including, but not limited to burying cables or pipes or inspection of piers and maintenance of existing intake and outfall lines.

(5) Mineral extraction, including sand for restoring beaches, except in biologically sensitive areas.

(6) Restoration purposes or creation of new habitat areas.

(7) Nature study, mariculture, or similar resource-dependent activities.

(8) Minor fill for improving shoreline appearance or public access to the water.

(b) The design and location of new or expanded facilities shall, to the extent practicable take advantage of existing water depths, water circulation, siltation patterns, and means available to reduce controllable sedimentation so as to diminish the need for future dredging.

(c) Dredging shall be planned, scheduled and carried out to minimize disruption to fish and bird breeding and migrations, marine habitats, and water circulation. Bottom sediments or sediment elutriate shall be analyzed for toxicants prior to dredging or mining, and where water quality standards are met, dredge spoils may be deposited in open coastal water sites designated to minimize potential adverse impacts on marine organisms, or in confined coastal waters designated as fill sites by the master plan where such spoil can be isolated and contained, or in fill basins on upland sites. Dredge material shall not be transported from coastal waters into estuarine or fresh water areas for disposal.

Section 30706 states:

30706. In addition to the other provisions of this chapter, the policies contained in this section shall govern filling seaward of the mean high tide line within the jurisdiction of ports:

(a) The water area to be filled shall be the minimum necessary to achieve the purpose of the fill.

(b) The nature, location, and extent of any fill, including the disposal of dredge spoils within an area designated for fill, shall minimize harmful effects to coastal resources, such as water quality, fish or wildlife resources, recreational resources, or sand transport systems, and shall minimize reductions of the volume, surface area or circulation of water.

(c) The fill is constructed in accordance with sound safety standards which will afford reasonable protection to persons and property against the hazards of unstable geologic or soil conditions or of flood or storm waters.

(d) The fill is consistent with navigational safety.

It is apparent that the Corps of Engineers Master Planning Program for the Los Angeles-Long Beach harbor complex and the Coastal Commission port planning activities need to be closely coordinated. We look forward to commenting on your revised Environmental Impact Statement for the Los Angeles Harbor project.

We would like to submit for your record a copy of the Coastal Act of 1976. Chapter 8 of the Act is the chapter which governs port development and planning.

Michael Dadasovich, our Port Coordinator, is available to answer any questions you have on the Coastal Act or the Commission's planning activities in the Ports of Los Angeles and Long Beach.

Very truly yours,

Joseph E. Bodovitz

JOSEPH E. BODOVITZ
Executive Director

Attachment

STATE OF CALIFORNIA—RESOURCES AGENCY EDMUND G. BROWN JR., Governor

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD—
LOS ANGELES REGION
107 SOUTH BROADWAY, SUITE 4027
LOS ANGELES, CALIFORNIA 90012
(213) 620-4460

FEB 24 1978

Department of the Army
Los Angeles District, Corps of Engineers
P. O. Box 2711
Los Angeles, California 90053

ATTENTION: Colonel Hugh G. Robinson, CE
District Engineer

Gentlemen:

We have reviewed the Public Announcement Concerning The Proposed Los Angeles Harbor Landfill, dated February 6, 1978.

This project originally involved the filling of 187 acres, including part of Restricted Anchorage 207.616 near Reeves Field Harbor and the area immediately west of the Los Angeles-Long Beach city limits. In November 1977, the plan was altered to propose the filling of 288 acres, including all of Reeves Field Harbor and the area directly to the south. The latest revision eliminates the filling of Reeves Field Harbor. Instead, it is now proposed to fill 200 acres adjacent to and east of Pier 301, using spoil generated from Main Channel dredging.

If an environmental evaluation is to be prepared on the water quality and related impacts of the present proposal, the following areas should be addressed in detail:

1) The proposed landfill area includes the present site of the Terminal Island Treatment Plant (TITP) wastewater outfall line. Filling of this area will necessitate either an extension of the line, or an alternative site for discharge of the TITP effluent. The ramifications of this should be explored with the City of Los Angeles, Bureau of Engineering and/or Bureau of Sanitation.

   The proposed landfill will also eliminate the existing Way Street Drain, now used as an outfall for the discharge of non-process wastes from certain of the tuna canneries. The drain is located on Pier 301 near its junction with Terminal Island proper. (Latitude 33°44'13"; Longitude 118°15'23"). Filling of the proposed site will require an extension of this line.

2) The loss of benthic habitat resulting from the 200-acre landfill and its concomitant mitigation, i.e., providing about 1½ miles of rocky intertidal habitat as a "trade-off", should be thoroughly analyzed. The extent of the biotic loss (plankton, nekton, benthos, and net biomass) and its effect on the ecology of the harbor should be evaluated.

3) Any effects the newly-filled area may have on the circulation of the outer harbor and/or the flushing of the inner harbor should be examined in light of Vicksburg model studies for the proposed harbor configuration.

4) The suitability of the dredged spoil proposed for use as fill should be assessed in relation to current ocean dumping criteria.

Thank you for the opportunity to review this announcement.

Very truly yours,

RAYMOND M. HERTEL
Executive Officer
By
Lewis A. Schinazi
LEWIS A. SCHINAZI
Environmental Specialist

cc: City of Los Angeles, Bureau of Sanitation
ATTN: Jack D. Betz
City of Los Angeles, Wastewater Systems Engineering Division
ATTN: Clayton Todd
Port of Los Angeles

FRED B. CRAWFORD
GENERAL MANAGER

MAIL ADDRESS:
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SAN PEDRO, CALIFORNIA 90733

CABLE ADDRESS:
LAPORT

(213) 832-7241
(213) 775-3231

PORT OF LOS ANGELES

CITY OF LOS ANGELES
TOM BRADLEY
MAYOR

August 7, 1978

Col. Gwynn A. Teague
District Engineer
Los Angeles District, Corps of Engineers
P. O. Box 2711
Los Angeles, CA 90053

Gentlemen:

SUBJECT: LOS ANGELES HARBOR DEEPENING PROJECT
Additional Dredging for the Port

Enclosure: Table of estimated dredging quantities

REQUEST:

It is requested that the additional areas of the harbor discussed herein be added to and incorporated in your engineering and design for the Los Angeles Harbor Deepening Project. This additional dredging is estimated to be approximately 2,900,000 cubic yards, and adds project depth in berthing areas along 41,650 feet of harbor waterfront adjoining the Federal Project dredging areas.

DISCUSSION:

A set of twenty-six drawings is returned herewith to your office. These drawings have been marked with various colored lines to represent the following:

The pencil line is the Port's approximation of the Corps' limit lines for the project, the blue line is the Port's dredge limit line, the red line is the pierhead line, and the green lines represent the dredge limits of the existing dredging site that is presently under contract by the Port.

It is our proposal to dredge to -45 feet an additional 50 foot wide section between the established pierhead lines and the Corps' project limit line. This is the general case except in locations where a review of the structural design of the wharves or other considerations require the Port to provide -45 draft nearer to the face of a wharf.

The Port has decided to add two major dredging areas that would have considerable benefit to the Port. One area is triangular in shape and lies easterly of Berths 49-50 and westerly of the L.A. entrance channel from the breakwater. This area is presently only approximately -20 feet and it is proposed to dredge it to -45 feet. In addition to this, a smaller triangular shaped area will be dredged to -51 feet to facilitate ship movements to and from Berths 49-50. This berth is presently at -51 foot draft.

Another area that was added to the Port's dredging area is in Slip 1. This addition will require a sheet to be added to the set of drawings. Enclosed is a set (4 sheets) of brownline tracings taken from our planimetric tracings that show Slip 1. Please prepare the additional sheet to be included with your drawings.

Enclosed is an estimate of the dredge quantities for the areas the Port is requesting to be included in the overall dredging project.

Sincerely,

F. B. CRAWFORD
General Manager

ABG/LHA:sad
Enclosures

SUMMATION OF QUANTITIES

CORPS OF ENGINEERS = 7,909,000 - 440,000* =		7,469,000
PORT OF LOS ANGELES =		2,391,000
		9,860,000

-1' to -2' OVERDREDGE, USE AVERAGE OF 1.5'

CORPS OF ENGINEERS = 1,414,167 - 95,277* =		1,318,889
PORT OF LOS ANGELES	=	506,290
		1,825,179

	9,860,000
	1,825,179
	11,685,179 cu yds
SAY	11,700,000 cu yds

* QUANTITIES TO BE DREDGED FOR SEASIDE CONTAINER TERMINAL PROJECT

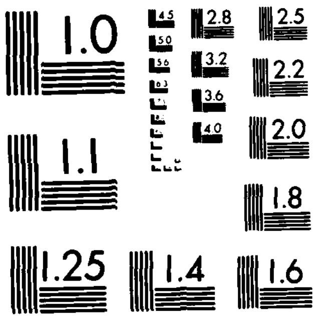
PORT OF LOS ANGELES DREDGE AREAS

BERTHS	DREDGE QUANTITY	OVER DREDGE QUANTITY	TOTAL
68-69	23,289	8,005	31,295
70-71	33,255	10,677	43,932
87-89	19,881	5,750	25,631
90-92	26,767	7,705	34,473
Slip 93	117,863	24,472	142,335
94-95	14,074	4,222	18,296
96-98	19,555	5,500	25,055
100-101	16,533	4,650	21,183
102-104	25,850	7,441	33,292
105-106 118-119	92,967	21,819	114,786
120	10,185	3,055	13,240
121-122	13,513	4,055	17,568
123-124	12,018	5,839	17,857
Angle Point Bet 124-126	16,273	5,511	21,783
126-128	22,500	4,500	27,000
129	20,833	4,167	24,999
130-131, 134-135 Basin	174,762	39,378	214,141
136-139	30,686	8,630	39,316
142-143	19,624	5,519	25,144
144-147	48,033	13,827	61,860
148-149	19,200	5,400	24,600

BERTHS	DREDGE QUANTITY	OVER DREDGE QUANTITY	TOTAL
150-151	18,489	5,778	24,266
Slip 1	226,064	49,919	275,983
170-171	15,555	4,000	19,555
172-174	25,422	7,150	32,572
175-176 & across slips	60,555	20,354	80,909
191-193	24,100	6,753	30,853
194-195	18,667	5,250	23,917
196-200A	205,838	27,000	232,838
206	13,679	3,458	17,137
207-209	29,167	6,562	35,729
210-211	13,611	3,305	16,917
212-213	21,852	6,556	28,408
214-215	17,222	6,200	23,422
216-218	14,933	4,200	19,133
219-220	29,517	8,497	38,014
221-222	18,150	5,250	23,375
222-225	17,244	4,850	22,094
227-229 & across Slip 228	30,482	6,245	36,728
234(Utility Crossing)	6,533	1,322	7,855
236-238	38,215	11,051	49,266

AD-A171 216 LOS ANGELES - LONG BEACH HARBORS CALIFORNIA LOS ANGELES HARBOR DEEPENING. (U) ARMY ENGINEER DISTRICT LOS ANGELES CA JAN 80 3/6

UNCLASSIFIED F/G 13/2 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

BERTHS	DREDGE QUANTITY	OVER DREDGE QUANTITY	TOTAL
Dredge to 45' area of bulk-loader	494,779	39,680	534,459
Dredge to 45' area east of bulkloader adjourning Corps limit line	246,338	65,983	312,321
Dredge to 51' area east of bulkloader	27,222	6,805	34,027
TOTAL	2,391,295	506,290	2,897,585
		Say	2,900,000

JACK L. WELLS
GENERAL MANAGER

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P. O. Box 151
SAN PEDRO, CALIFORNIA 90733

CABLE ADDRESS:
LAPORT

(213) 548-7801

PORT OF LOS ANGELES

CITY OF LOS ANGELES
TOM BRADLEY
MAYOR

January 9, 1979

Col. Gwynn A. Teague
District Engineer
Los Angeles District, Corps of Engineers
P. O. Box 2711
Los Angeles, CA 90053

Dear Sir:

SUBJECT: LOS ANGELES HARBOR DEEPENING PROJECT
Estimate of Total Dredge Quantities for Project

ENCLOSURES:

A. Copy of Summation of Quantities

B. Copy of L.A.H.D. Drawing No. 5-4755, entitled "New Approach Channel Configuration"

C. Copy of L.A.H.D. Drawing No. 5-4751, entitled "Supertanker Channel and Turning Basin Dredging Areas"

REQUEST:

It is requested that the revised Harbor approach channel configuration, as shown on the enclosed Drawing No. 5-4755, and those areas in the Supertanker Channel and Turning Basin, as shown on the enclosed Drawing No. 5-4751, be included in the Corps' project to deepen the Port. It is further requested that the additional dredge quantities as specified in the enclosed Summation of Quantities be included in the Corps' project.

INFORMATION:

Your letter dated November 28, 1978 transmitted a letter from the Commander, Eleventh Coast Guard District, which proposed a new approach channel configuration for the breakwater entrance to the Port. These areas would be to a depth of -51 feet MLLW and would be dredged as a part of the Corps' Deepening project. The configuration is outlined on the enclosed Drawing No. 5-4755. This new approach channel configuration is satisfactory to the Port and it is requested that the configuration be incorporated into the Corps' Project. The dredge quantity for this configuration is estimated to be an additional 2,250,000 cubic yards.

The Port presently has a Supertanker Channel with Turning Basin that commences at the breakwater entrance and terminates at Berths 45-47, which is the Port's deep draft petroleum terminal. The design depth for this Supertanker Channel was -51 feet MLLW; however, it has been determined by soundings that certain areas within its limits are not at the design depth, but rather in the -47 foot to -49 foot depth range. These depths were caused by several outcroppings and by sedimentation deposited by outer harbor currents. These "high spots" in this channel and turning basin are shown on the enclosed Drawing No. 5-4751 and it is requested that they be included in the Corps' Dredging Project. The dredge quantity from these areas is estimated to be 160,000 cubic yards.

On August 7, 1978, a table of estimated dredge quantities was transmitted to your office. The enclosed Summation of Quantities is the Port's revised estimate of the dredge quantities divided into the various areas of responsibility and lists all the areas that the Port has requested to be added to the project, including those additional dredge areas discussed in this letter. Furthermore, the enclosed revised estimate has been modified from the one transmitted on August 7, 1978 by using an assumed 2 foot overdredge depth allowance versus the previously used 1.5 foot overdredge depth. The Port's total estimated dredge quantity for the project is 14,700,000 cubic yards of material.

A review of the necessary quantities to fill the presently proposed 200 acre landfill site shows that the quantity of 14,700,000 cubic yards will fill the area to approximately +32 feet MLLW elevation. This height is considerably higher than the desired final elevation of +17 feet; however, since the environmental mitigation solution has not been finalized with the affected State and Federal agencies, the projected excess dredge material could be available to provide the discussed shallow water habitat to the east of the landfill site and to make future landfills.

Very truly yours,

JACK L. WELLS
General Manager

ABG/LHA:sad
Enclosures

SUMMATION OF QUANTITIES

CORPS OF ENGINEERS 7,909,000 - 440,000* =	7,469,000
PORT OF LOS ANGELES =	2,391,000
	9,860,000
OVERDREDGE, USE 2 FEET	
CORPS OF ENGINEERS = 1,885,556 - 95,277* =	1,790,279
PORT OF LOS ANGELES =	675,039
	2,465,318
COMBINED PORT OF LOS ANGELES & CORPS AREAS - APPROACHES TO AND MAIN CHANNEL ENTRANCE	
CORPS OF ENGINEERS =	415,185
OVERDREDGE =	227,404
	642,589
PORT OF LOS ANGELES =	1,409,808
OVERDREDGE =	166,229
	1,576,037
PORT OF LOS ANGELES (Existing Supertanker Turning Basin)	160,000
CORPS OF ENGINEERS DREDGE QUANTITIES	7,469,000
	1,790,279
Total Corps' Quantity	642,589
	9,901,868
PORT OF LOS ANGELES DREDGE QUANTITIES	
	2,391,000
	675,039
	1,576,037
Total Ports' Quantity	160,000
	4,802,076
	9,901,868
	4,802,076
TOTAL	14,703,944
SAY	14,700,000 cu.yds.

*QUANTITIES TO BE DREDGED FOR SEASIDE CONTAINER TERMINAL PROJECT

PORT OF LOS ANGELES DREDGE AREAS

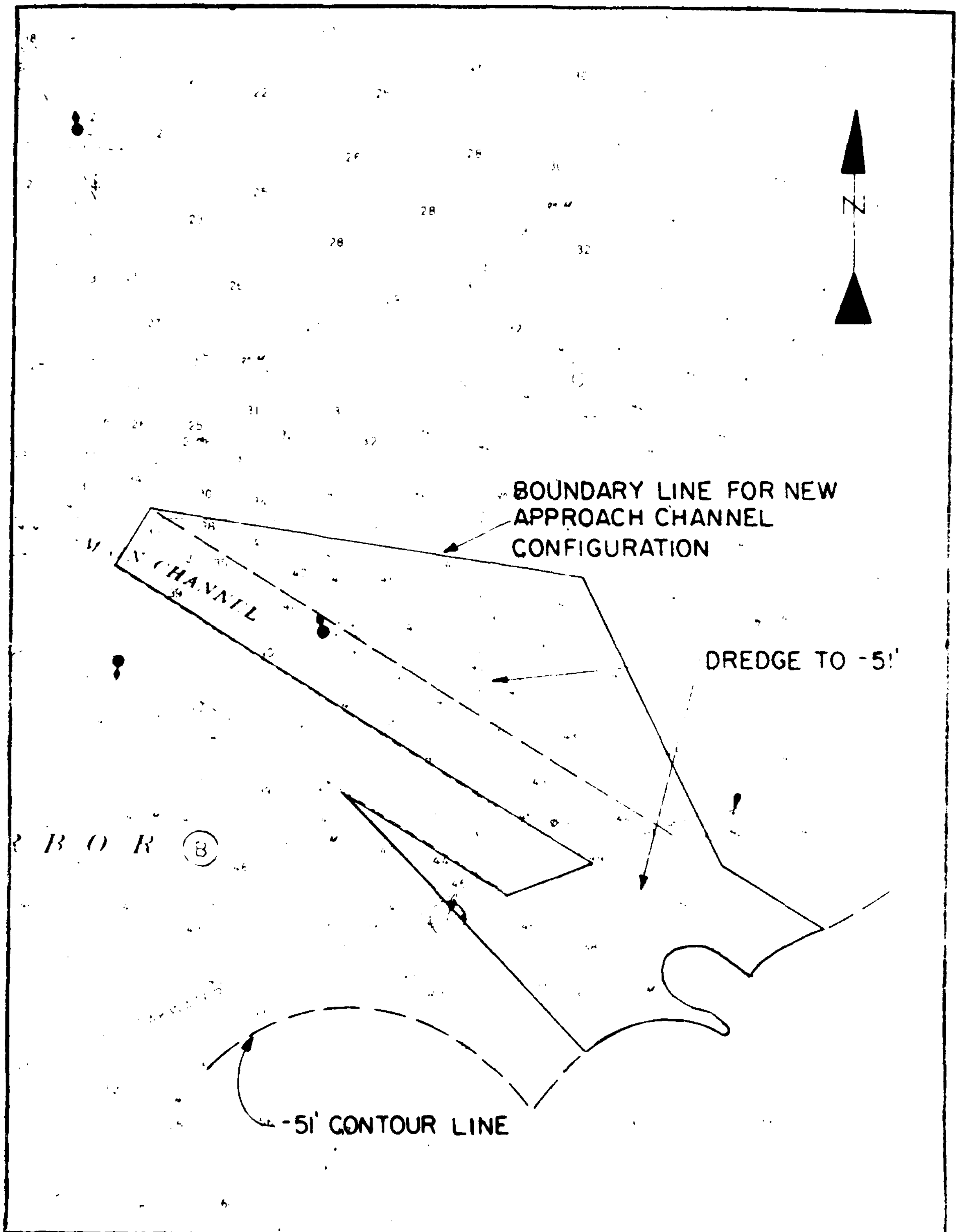
BERTHS	DREDGE QUANTITY	OVER DREDGE QUANTITY	TOTAL
68-69	23,289	10,673	33,962
70-71	33,255	14,236	47,491
87-89	19,881	7,666	27,547
90-92	26,767	10,273	37,040
Slip 93	117,863	32,629	150,492
94-95	14,074	5,629	19,703
96-98	19,555	7,333	26,888
100-101	16,533	6,200	22,733
102-104	25,850	9,921	35,771
105-106 118-119	92,967	29,092	122,059
120	10,185	4,073	14,258
121-122	13,513	5,406	18,919
123-124	12,018	7,785	19,903
Angle Point Bet 124-126	16,273	7,348	23,621
126-128	22,500	6,000	28,500
129	20,833	5,556	26,389
130-131, 134-135 Basin	174,762	52,504	227,266
136-139	30,686	11,506	42,192
142-143	19,624	7,359	26,982
144-147	48,033	18,436	66,469
148-149	19,200	7,200	26,400

BERTHS	DREDGE QUANTITY	OVER DREDGE QUANTITY	TOTAL
150-151	18,489	7,704	26,193
Slip 1	226,064	66,558	292,622
170-171	15,555	5,333	20,888
172-174	25,422	9,533	34,955
1/5-176 & across slip 5	60,555	27,138	87,693
191-193	24,100	9,004	33,104
194-195	18,667	7,000	25,667
196-200A	205,838	36,000	241,838
206	13,679	4,610	18,289
207-209	29,167	8,749	37,916
210-211	13,611	4,406	18,017
212-213	21,852	8,741	29,963
214-215	17,222	8,266	25,488
216-218	14,933	5,600	20,533
219-220	29,517	11,329	40,846
221-222	18,150	7,000	25,150
222-225	17,244	6,466	23,710
227-229 & across slip 228	30,482	8,326	38,808
234 (Utility Crossing)	6,533	1,762	8,295
236-238	38,215	14,734	52,949

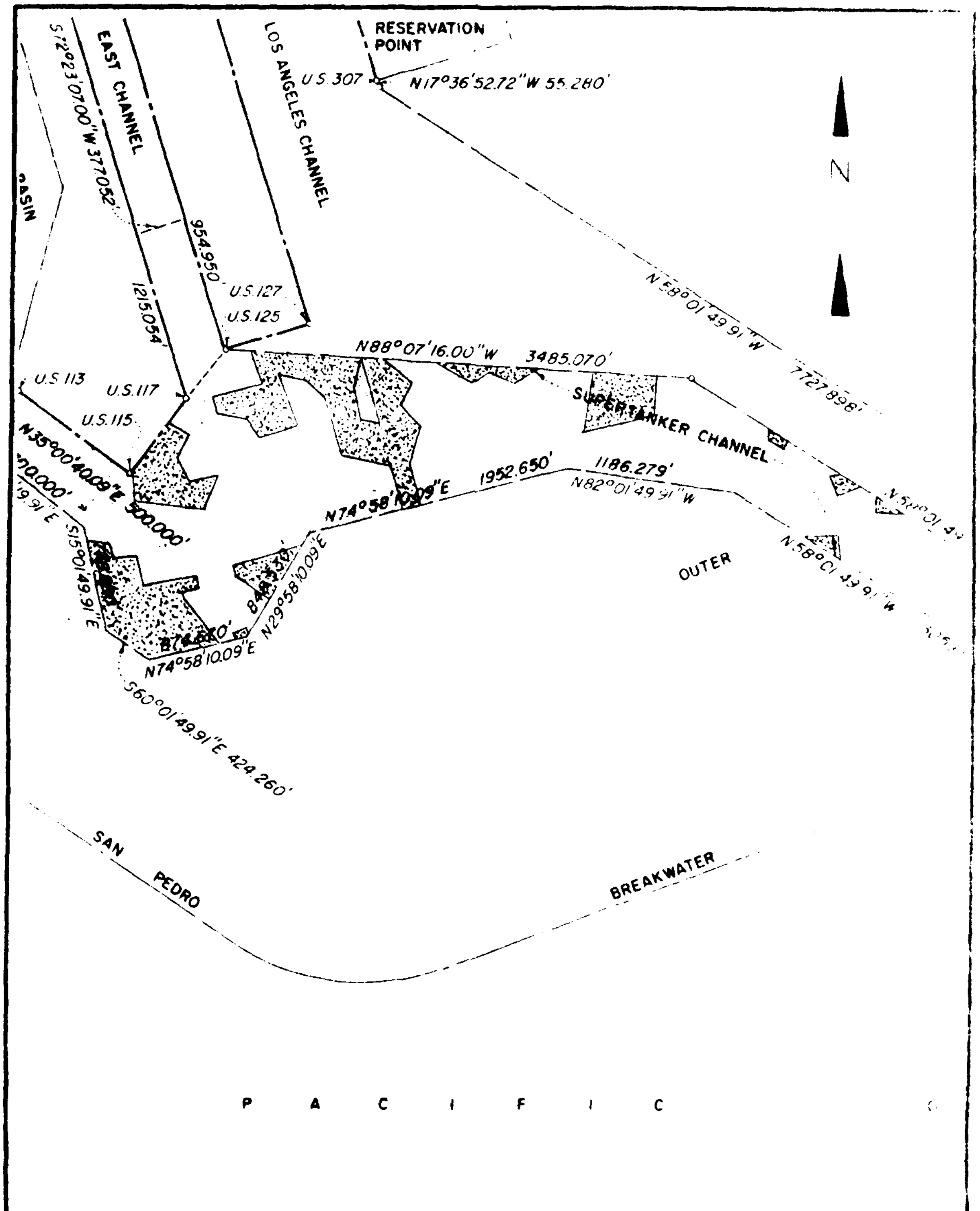
BERTHS	DREDGE QUANTITY	OVER DREDGE QUANTITY	TOTAL
Dredge to 45' area of bulk-loader	494,779	52,906	547,685
Dredge to 45' area east of bulkloader adjourning Corps limit line	246,338	87,977	334,315
Dredge to 51' area east of bulkloader	27,222	9,073	36,295
TOTAL	2,391,295	675,039	3,066,334
		Say	3,100,000

COMBINED PORT OF LOS ANGELES AND CORPS OF ENGINEER'S DREDGE AREAS - APPROACHES TO AND MAIN ENTRANCE CHANNEL DREDGE TO -51 FOOT MLLW

PORT OF LOS ANGELES	1,409,808
OVERDREDGE	166,421
	1,576,229 cu.yds.
CORPS OF ENGINEERS	445,185
OVERDREDGE	227,404
	672,589 cu.yds.
PORT OF LOS ANGELES EXISTING SUPERTANKER AND TURNING BASIN	160,000 cu.yds.



SCALE 1" = 1000'	RECOMMENDED FOR APPROVAL	NEW APPROACH CHANNEL CONFIGURATION	
DRAWN AB	CHIEF OF DESIGNS		
CHECKED			
DESIGN ARCH ENGR ANDERSON	ASSISTANT CHIEF HARBOR ENGINEER	APPROVED CHIEF HARBOR ENGR	PORT OF LOS ANGELES ENGINEERING DIVISION P.O. BOX 151 SAN PEDRO CALIF
			DRAWING NUMBER 5-4755



AREAS SHOWN TO BE DREDGED TO -51' M L L W

SCALE 1"=1000'	DATE	RECOMMENDED FOR APPROVAL	SUPER TANKER CHANNEL AND TURNING BASIN DREDGING AREAS		
DRAWN ABG	12/78	CHIEF OF DESIGNS			
CHECKED BGG	1/79				
DESIGN. ARCH. ENGR.					
L. ANDERSON		ASSISTANT CHIEF HARBOR ENGINEER	APPROVED CHIEF HARBOR ENGR.	PORT OF LOS ANGELES ENGINEERING DIVISION P.O. BOX 151 SAN PEDRO, CALIF.	DRAWING NUMBER 5-475

E. L. "ROY" PERRY
EXECUTIVE DIRECTOR

MAIL ADDRESS:
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SAN PEDRO, CALIFORNIA 90733

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LAPORT

(213) 548-7801

PORT OF LOS ANGELES

CITY OF LOS ANGELES
TOM BRADLEY
MAYOR

August 9, 1979

Colonel Gwynn A. Teague
District Engineer
United States Corps of Engineers
Department of the Army
P. O. Box 2711
Los Angeles, California 90053

Dear Sir:

SUBJECT: LOS ANGELES HARBOR DEEPENING PROJECT - PORT RELATED CONSTRUCTION ITEMS

REQUEST:

The Port of Los Angeles requests that the following work be included as part of your contract work for the subject project:

1. "Non-federal" dredging to the depths as indicated on the Recommended Plan.

2. Removal of and leaving in place certain submarine utility lines.

3. Landfill containment dikes.

INFORMATION:

As discussed in both your General Design Memorandum and the EIR/EIS, the Port of Los Angeles proposes to have work performed in excess of that to be accomplished by the Corps of Engineers. It is understood that the Port will reimburse the Corps for all of this additional work.

Additional dredging of approximately ~~4.6~~ 5.0 million cubic yards is proposed by the Port in excess of the approximate 9.7 million cubic yards of dredging by the Corps. This additional dredging involves the deepening of designated berth areas and a deeper approach to the supertanker and bulkloader berths.

Removal of the following public agency owned abandoned utility lines is to be included as part of the Corps' contract:

1. The 20-inch abandoned sewer line housing communication cables in Utility Corridor A.

2. The 16-inch abandoned sewer in Utility Corridor C.

3. The 12-inch abandoned water line in Utility Corridor C.

4. One 6-inch and two 4-inch pipeline conduits in Utility Corridor C.

Moreover, the Los Angeles City Department of Water & Power's 20-inch high pressure waterline in Utility Corridor A, indicated to be removed, is to remain in place. Special precautions will be required by the contractor to avert accidental damage to the line because of its shallow depth.

Construction of containment dikes of rock for the 190 acre landfill under the same contract as the dredging is requested. The dike design is based on a "two-lift" design, requiring placement of dredged fill for the foundation of the upper lift of rock. Therefore, close coordination between the dredging and rock placement operations is mandatory and best accomplished under one contractor.

The presently estimated costs are as follows:

a)	Non-federal (Port) dredging	
	Mobilization & Demobilization	$ 714,000.
	3,926,000 cu.yd. @ $1.95	7,656,000.
	1,058,000 cu.yd. @ $3.65	3,862,000.
	12% contingencies	1,468,000.
	Total	$13,700,000.
b)	Utility removals	
	Utility Corridor A - 20" sewer	$ 100,000.
	Special dredging for 20" waterline	400,000.
	Utility Corridor C	
	16" sewer	53,000.
	12" water	50,000.
	3 oil lines	50,000
	Total	$ 653,000.
c)	Retaining dikes	
	South dike	$ 7,019,000.
	East dike	2,297,000.
	1000-foot breakwater	2,294,000
		11,610,000
	12% contingencies	1,390,000
		$13,000,000
	GRAND TOTAL.	$27,353,000.

The appropriate Board of Harbor Commissioners' Resolution will be prepared when transfer of funds is required.

Very truly yours,

Ernest L. Perry

ERNEST L. PERRY
Executive Director

LHA/JIN:eo

cc: Mr. Don Tillman, City Engineer
Mr. Paul H. Lane, Chief Engineer
of Water Works, Dept. Water & Power

United States Department of the Interior

FISH AND WILDLIFE SERVICE
LLOYD 500 BUILDING, SUITE 1692
500 N.E. MULTNOMAH STREET
PORTLAND, OREGON 97232

March 23, 1978

In reply refer to:
AFA-SE

District Engineer
Los Angeles District
Corps of Engineers
P.O. Box 2711
Los Angeles, California 90053

Attention: Mr. Norman Arno

Dear Mr. Arno:

This constitutes a reply to your letter of January 10, 1978, requesting formal consultation as provided for in Section 7 of the Endangered Species Act of 1973, relative to the Corps of Engineers' Los Angeles-Long Beach Harbor project. This consultation is to be conducted according to procedures specified in the January 4, 1978, "Interagency Cooperation Regulations." We have conducted a threshold examination of this project and have concluded that it may adversely affect the endangered California least tern.

As currently proposed, the Corps' project would fill 200 acres of water area within Los Angeles Harbor. Although Critical Habitat under Section 7 has not been determined for the California least tern, the majority of this fill area is within the area determined by the California Least Tern Recovery Team to be essential habitat for the least tern because of its proximity to the Terminal Island nesting site and its importance as a source of forage fish. However, we have insufficient information to determine whether the Corps' project is likely to jeopardize the continued existence of the California least tern. To allow us to make this determination, we request that the Corps of Engineers provide us with the following information:

1. A detailed study of the Terminal Island least tern colony's preferred feeding areas.

2. Prediction of potential impacts of the proposed project on forage fish populations in the areas utilized for feeding by the Terminal Island least tern colony.

3. A description of uses to which the new fill will put, and potential impacts of these uses on the least tern colony.

4. Determination of indirect impacts of the project on land uses in adjacent area as might be related to the least tern.

5. A determination of the potential impacts of turbidity and siltation occurring during project construction on least tern feeding behavior.

We believe that request number (1), above, may be answered by a feeding behavior study to be completed by the California Department of Fish and Game (DFG) between March and October of 1978. However, it is nevertheless the responsibility of the Corps of Engineers to insure that this information is transferred to the Fish and Wildlife Service and to gather any supplemental data needed to meet our request. Further information on DFG's study can be obtained from Paul Kelly (213-590-5189).

A final biological opinion will be issued within 60 days of receipt of adequate information in response to the above requests.

Sincerely yours,

R. Kahler Martinson

R. Kahler Martinson
Regional Director

SPLPD-C

26 July 1978

Mr. R. Kahler Martinson
Regional Director
U.S. Fish & Wildlife Service
Lloyd 500 Building, Suite 1691
500 N. E. Multnomah Street
Portland, Oregon 97232

Dear Mr. Martinson:

This letter is in response to your 23 March 1978 letter concerning our request for a Section 7 consultation on the Los Angeles-Long Beach harbors project.

In response to your request for a detailed study of the Terminal Island least tern colony's feeding areas, we understand that the study (which is being conducted by the California Department of Fish and Game) will be concluded and information will be available by 1 September 1978. We suggest that you contact that agency directly. We would appreciate your informing us if you experience any delay or difficulty in obtaining the information.

In response to your request for a description of uses to which the new fill will be put, we have been informed by the Port of Los Angeles that they presently intend to use the landfill for a bulk coal export facility (Incl 1).

The remaining information that you requested would require extensive studies that would result in a considerable time delay for the project. We believe that there is sufficient data available upon which to base a determination of the impacts of our authorized project on the least tern. Because of the urgency of the Congressional mandate to initiate construction, we are requesting that you conclude the Section 7 determination by 15 September 1978. We realize that your answer will be based on available information and are willing to accept a determination based solely on that.

SPLED-CW
Mr. R. Kahler Martinson

26 July 1978

We have been in contact with Mr. James J. McKevitt of your field office and as indicated in our 17 July 1978 letter (Incl 2), he is willing to work on this determination in an expeditous manner.

If we can be of any further assistance to you in making your determination, please do not hesitate to contact us.

Sincerely yours,

2 Incl
As stated

ROBERT H. [illegible]
Lieutenant Colonel, CE
Acting District Engineer

United States Department of the Interior

FISH AND WILDLIFE SERVICE
LLOYD 500 BUILDING, SUITE 1692
500 N.E. MULTNOMAH STREET
PORTLAND, OREGON 97232

September 27, 1978

In reply refer to:
AFA-SE (1-1-78-F-19)

Colonel Gwynn A. Teague
District Engineer
Los Angeles District
Corps of Engineers
P.O. Box 2711
Los Angeles, California 90053

Dear Colonel Teague:

This letter is in further response to your request dated January 10, 1978, requesting formal consultation on the proposed Los Angeles Harbor Interim Project, Los Angeles County, California.

Our earlier threshold examination statement was submitted to you on March 23, 1978. In this statement, we indicated that additional information was required before we could issue our biological opinion on the project. Part of the information required was a site specific feeding study of the Terminal Island least tern colony. However, due to several unfortunate disruptive activities at the Terminal Island site, the terns chose not to nest there this year. Therefore, a detailed feeding study of the site became impossible this year and would require at least another year's delay to obtain. As an alternative to this further delay, it was agreed upon by the Corps of Engineers and the Port of Los Angeles that utilization of existing information and the results of the California Department of Fish and Game's 1978 Statewide Feeding Study of least terns would serve as acceptable criteria upon which our biological opinion would be based.

We have reviewed the existing information concerning the Terminal Island nesting site, and the 1978 Statewide Feeding

Study conducted by the California Department of Fish and Game, and are now prepared to provide our biological opinion, as prescribed by the "Interagency Cooperation Regulations" for the Endangered Species Act of 1973 issued in the January 4, 1978 Federal Register.

The Fish and Wildlife Service (FWS) is of the opinion that the project, as presently proposed, is likely to jeopardize the continued existence of the endangered California Least Tern by reducing the likelihood of their recovery through direct and indirect impacts of the proposed project.

The California Least Tern is a migratory bird generally occupying its breeding area from April through August. The majority of birds nest along the coast of southern California from southern Santa Barbara County south through San Diego County. Nesting activities of the terns have been monitored by the California Department of Fish and Game (CDFG), and members of the California Least Tern Recovery Team since 1970.[1/] These nesting census studies indicate that the Terminal Island area has been utilized continuously since 1973. In 1973 and 1974, the Reeves Field site was successfully utilized as a nesting site by 14 nesting pairs of least terns.[2/][3/] This successful nesting was aided by the Los Angeles Police Department which provided protection of the nesting site from disturbance. The terns had also been observed in courtship flights over the Ferry Street area of Terminal Island, but were prevented from nesting there due to grading and landfill activities.[2/][3/]

In 1975, the terns were prevented from using the Reeves Field site due to its use as a parking lot for imported cars. Fortunately, the Ferry Street site was not under construction pressure that year and terns were able to successfully nest there. There was a total of 40 nests established at the Ferry Street site during 1975.[4/] In 1976, the Ferry Street site was not usable due to the presence of unsuitable plant growth and disturbance by helicopter training flights.[5/] The Reeves Field site was left undisturbed that year and by May, 49 nests were present; by June 29, there were 25 more. Fledging success was good with 50+ juveniles counted. Least terns returned to the Reeves Field site in 1977; however, the Ferry Street site remained unsuitable for nesting due to heavy vegetation growth and storage of petroleum coke in the area.[6/] The 1977 season at Reeves Field was very successful with 80 young fledged from 85 nests. This represented the third

largest nesting site in the state and the second highest fledging count for the 1977 season.

The 1978 season found no nesting at either the Ferry Street or Reeves Field sites. The reasons behind this total lack of nesting are not fully clear. No birds were observed courting over the Ferry Street site; however, courtship flights did occur over the Reeves Field site in typical prenesting behavior. Unfortunately, disturbance of the site at this critical period appears to have been enough to cause abandonment of the Reeves Field site for 1978.

As can be seen, the importance of the Terminal Island least tern colony is clearly evident and has steadily increased over the past 5 years. There has been a sixfold increase in the number of nests, and in 1977 the number of fledglings had risen to almost 20 percent of the state's total production.

As discussed earlier, our request for a detailed feeding study of the Terminal Island least tern colony was not possible this year; therefore, as agreed to by all parties,[8/][9/] we have based our information on past observations and the statewide feeding study conducted this year by the CDFG.

Data covering least tern foraging in Los Angeles Harbor consist of past census survey observations[10/][11/][12/], unpublished field observations of the 1973-1976 Allan Hancock Foundation[13/], 1978 observations in Los Angeles Harbor[14/][15/] and the 1978 Statewide Feeding Study[16/].

Review of available information indicates that the nearshore, shallow water (less than 20 feet depth) areas in close proximity (1/2-3/4 mile) to the Terminal Island nesting sites are the primary feeding areas utilized by the least tern when nesting on Terminal Island. The areas of highest usage during the past 5 years include the Seaplane Basin, shallow water area lying east and south of the Ferry Street nest site (the proposed fill area) and Fish Harbor. Several factors appear to influence the use of these areas. First, these areas comprise the major portion of the remaining shallow water (less than 20 feet) area of Los Angeles harbor. In observations of every other least tern colony in California, adults were found to prefer shallows or simulated shallow areas.[16/] The 1978 data also suggest that the various wrecks located along the northwest section of the proposed fill area may also serve to attract prey fish utilized by the terns.[14/]

Second, present data indicate that the area of the proposed fill is undergoing a recovery in water quality and benthic life and is improving in its value as a feeding area for various fish and fish eating species of birds.[15] In addition, large rafts of Surf Scoters have become almost constantly present. These birds feed on various shellfish and thus provide an indirect measure of the presence of plankton which is utilized as a food source of the shellfish, and by several of the bait fish on which the least tern feeds.

Finally, this feeding area is directly adjacent to the Reeves Field and Ferry Street nesting sites. The feeding area is vital to the terns during the period in which they feed their young.

Based on the importance of the Terminal Island colony and being cognizant of the above information, the Least Tern Recovery Team has recommended approximately 300 acres of Terminal Island and 500 acres of adjacent Los Angeles Harbor waters as candidate areas for a critical habitat determination.[7] Approximately 95 percent of the fill area would lie within the boundaries of this candidate critical habitat.

As presently proposed, the fill project would destroy approximately 40 percent of the feeding area identified as essential to the existence of the Terminal Island least tern colony. In addition, there are neither provisions provided which compensate for the direct loss of feeding area, nor that provide any protection of the known Reeves Field or Ferry Street nesting sites nor any nesting sites which may be established on the new fill site.

Based on the above discussion, the opinion of the Fish and Wildlife Service regarding impacts on endangered species by the presently proposed Los Angeles Harbor Interim (fill) Project is that the continued existence of the endangered California Least Tern will be jeopardized. This letter finalizes your consultation requested on January 10, 1978.

Though this consultation is now completed, interagency cooperation regulations allow for reinitiation of a consultation if new information is forwarded, or the activity

or project is subsequently modified. It is under this latter condition we believe the Corps could reinitiate consultation based on the following or similar recommendations:

1. The proposed fill be disposed of at sea or so located within the harbor such that it would not adversely impact the endangered least tern.

2. The Reeves Field and Ferry Street nesting sites be protected and maintained as nesting sites until such time that they may become permanently abandoned for new nesting sites established by the terns elsewhere in Los Angeles Harbor.

3. Provisions be made to protect any new nesting sites that may become established on the proposed fill area or elsewhere in Los Angeles Harbor.

4. Compensation, in the form of habitat replacement, be included in the project to make up for the loss of feeding area that would result from the fill project.

5. Any other such measure that would result in a net neutral or beneficial impact upon the least tern.

These above recommendations are not all inclusive and further analyses by both our staffs could modify these recommendations and/or may lead to additional recommendations.

We would appreciate notification of your intent in light of this opinion and the above discussion.

Sincerely yours,

William H. Meyer

William H. Meyer
Acting Regional Director

Enclosure

REFERENCES

(1) Craig, Alan. 1970. Survey of California least tern nesting sites. Report to the Resources Agency, California Department of Fish and Game.

(2) Bender, Kristen. 1973. California least tern census and nesting survey, 1973. A report to the Resources Agency, California Department of Fish and Game.

(3) Bender, Kristen. 1974. California least tern population and nesting survey, 1974. A report to the Resources Agency, California Department of Fish and Game.

(4) Massey, Barbara. 1975. California least tern census and nesting survey, 1975. A report to the Resources Agency, California Department of Fish and Game.

(5) Bender, Kristen, E.B. Cooper, B. Massey and S.R. Wilbur. 1976. California least tern nesting survey, 1976. A report for the U.S. Fish and Wildlife Service and California Department of Fish and Game.

(6) Atwood, J.L., F.D. Jorgensen, R.M. Jurek and T.D. Manolis. 1977. California least tern census and nesting survey, 1977. A report for the Resources Agency, California Department of Fish and Game.

(7) California Least Tern Recovery Team. 1977. California Least Tern Recovery Plan, 1977, as amended. A report to the U.S. Fish and Wildlife Service, Portland, Oregon.

(8) Letter of 26 July 1978 from Leiutenant Colonel Robert H. Reinen, Acting District Engineer, Corps of Engineers, Los Angeles District, to Regional Director, U.S. Fish and Wildlife Service, Portland, Oregon.

(9) Crawford, Fred B. 1978. Personal communication at third Wildlife Workshop conducted by Los Angeles Harbor Department on August 17, 1978.

(10) Massey, Barbara W. 1978. Summary memo on observed feeding of least terns in Los Angeles Harbor during 1975-1976.

(11) Mulligan, Michael J. 1978. Memo concerning least tern observations at Reeves Field during 1976-1977.

(12) Atwood, Jon. 1978. Memo on least tern foraging activity, Terminal Island area.

(13) Allan Hancock Foundation. 1976. Unpublished observations of least tern utilization of Los Angeles Harbor collected by Allan Hancock Foundation, University of Southern California 1973-1976 under U.S. Army Corps of Engineers Contract Number DACW09-73-0112.

(14) Hay, Douglas B. 1978. A preliminary report of the foraging behavior and ecology of the California least tern with respect to Los Angeles Harbor. Prepared for the U.S. Fish and Wildlife Service and California Department of Fish and Game, September 1978.

(15) U.S. Fish and Wildlife Service. 1978. Resource analyses and observations of avian use of portions of Los Angeles Harbor. Field data collected by the Laguna Niguel Field Office, 1978.

(16) California Department of Fish and Game. 1978. Draft Statewide Feeding Study of the California least tern, 1978.

SPLED-CW 22 November 1978

Mr. Kahler Martinson
Regional Director
U.S. Fish and Wildlife Service
Lloyd 500 Building, Suite 1692
500 N.E. Multnomah Street
Portland, Oregon 97232

Dear Mr. Martinson:

This letter is in response to your Section 7 report on the Los Angeles Harbor deepening project and to marine habitat issues discussed at the meeting held in your office on 25 October 1978. A copy of our memorandum of this meeting was provided to your office with our letter of 6 November 1978. This memorandum outlined the understandings and directions that we can take with the Section 7 proceedings. I feel, and hope you will concur, that the Section 7 consultation should be reinitiated based on the proposed modifications outlined in this letter.

Personnel of the Los Angeles District have met with James Slawson, National Marine Fisheries Service (NMF); Dick Nitsos, California Department of Fish and Game (Cal F&G); Dr. Charles Collins, Paul Kelly, Barbara Massey, Kristen Bender, John Atwood, Ron Jurek, and Alan Craig, members of, or consultants for, the Least Tern Recovery Team; and officials of the Los Angeles Harbor Department. On the basis of these meetings, we are proposing modifications to compensate for loss of marine habitat and possible effects on the California least tern. The proposals of NMF/Cal F&G, the consensus of the recovery team members and consultants, and our proposal, which was developed in good faith with the Harbor Department, are presented in the following paragraphs.

The NMF/Cal F&G proposal for compensation for loss of marine habitat consisted of creating shallower water habitat east of the proposed fill by placing sand on the area to form a sloping bottom. Their proposal also included a reduction in acreage of the landfill from 200 to 175 acres and an associated habitat replacement. It is recognized that marine fisheries interests would like to see the size of the fill area reduced further, if not totally eliminated. We can sympathize with this view as it relates to the preservation of marine habitat. However, as emphasized to you at our 25 October meeting, further substantive reduction in size of the fill area is not feasible.

The main objective of the Least Tern Recovery Team was the maintenance of a least tern colony on Terminal Island. Recovery team members and consultants provided the District with five proposals, outlined in the following paragraphs as proposals A through E. In all proposals, they indicated the unwillingness to relinquish an active nesting area until the terns had either deserted it or moved to another site.

Proposal A consists of the following elements:

a. Maintain the existing fence around the approximately 15-acre Reeves Field nesting site through the 1979 nesting season.

b. Prepare (to the specifications of the recovery team) and maintain (until the landfill is suitable for nesting-approximately 4 years) a 15-acre nesting site in the Ferry Street site area for the purpose of establishing this as the new nesting site. This would make the Reeves Field site available for use by the Harbor Department. The proposed Ferry Street site would be used as an experiment to gather data on methods of establishing nesting habitat.

c. Provide and maintain, until further compensation proposals are implemented for future harbor expansion, a similar 15-acre site on the landfill as a new site, allowing the harbor to utilize the Ferry Street site.

Proposal B consists of the following elements:

a. Maintain the fence and 15-acre Reeves Field nesting site until the landfill is suitable for nesting (approximately 4 years).

b. Provide a nesting site as outlined in "c" above.

Proposal C consists of maintaining the Reeves Field site until other plans could be implemented or until the least tern no longer nests on Terminal Island.

Proposal D contains the following elements:

a. Maintain the fence and Reeves Field nesting area to the specifications of the recovery team until completion of the project (no more than 4 years).

b. Construct, prepare, and maintain two 1-acre islands east of the landfill to the recovery team's specifications for nesting, making the Reeves Field site available for use by the Harbor Department.

SPLED-CW 22 November 1978
Mr. Kahler Martinson

Proposal E contains the following elements:

a. Relocate the landfill to the southeast by approximately 1,000 feet, forming an island and reducing the impact on shallow water habitat.

b. Implement proposal D.

We presented all of these proposals to the Harbor Department. On the basis of these proposals and discussions with Harbor Department officials, I recommend the following proposals which I believe compensate for the loss of marine habitat and ensure the continued existence of the least tern. The proposals are based on the assumption that the least terns nest on the sites provided. Two scenarios will need to be discussed in a future detailed proposal: first, if the terns do not return to nest or second, do not nest on the sites provided. The proposals are as follows:

a. Maintain the existing fence around the approximately 15-acre Reeves Field nesting site through the 1979 nesting season.

b. Prepare (to the specifications of the U.S. Fish and Wildlife Service) and maintain (until the landfill is suitable for nesting - approximately 4 years) a 15-acre nesting site in the Ferry Street site area for the purpose of establishing this as the new nesting site; this would make the Reeves Field site available for use by the Harbor Department. The proposed Ferry Street site would be used as an experiment to gather data on methods of establishing nesting habitat.

c. Provide and maintain, until further compensation proposals are implemented for future harbor expansion, a similar 15-acre site on the landfill as a new site, allowing the harbor to utilize the Ferry Street site.

d. Reduce the size of the landfill to 190 acres.

e. Provide shallower water habitat within the area bounded on the west by the landfill, on the north by the seaplane anchorage breakwater, on the east by a line west of the Port boundary, and on the south by a projected line from the south side of the landfill to the Port boundary.

f. Provide funds for studies of the Terminal Island colony nesting and feeding habitat that would start prior to the 1979 nesting season to determine the effectiveness of the proposals.

The additional costs of our recommended proposals will be borne by the Corps of Engineers and the Los Angeles Harbor Department. The Corps will provide the funds for the study through completion of the project, and the Harbor Department will provide the funds from completion of the project to completion of the study.

The U.S. Fish and Wildlife Service, the National Marine Fisheries Service, the California Department of Fish and Game, the Corps, and the Harbor Department will need to develop an agreement that provides details of the proposal and its implementation.

The concept of my proposals has the informal acceptance of personnel of the California Department of Fish and Game and the National Marine Fisheries Service and representatives of the Least Tern Recovery Team. Maintenance of the Reeves Field site and development of the Ferry Street site will require immediate action between your office and the Harbor Department to assure least tern nesting in 1979. Again, we hope that this plan meets with your approval so that we can proceed with the project with the knowledge that the continued existence of the California least tern will not be jeopardized. I look forward to your reply concerning this proposed modification plan.

Sincerely yours,

GWYNN A. TEAGUE
Colonel, CE
District Engineer

CF:
Director, Southwest Region
National Marine Fisheries Service
300 S. Ferry Street
Terminal Island, CA 90731

Manager, Region 5
California Department of Fish and Game
350 Golden Shore
Long Beach, CA 90802

United States Department of the Interior

FISH AND WILDLIFE SERVICE
LLOYD 500 BUILDING, SUITE 1692
500 N.E. MULTNOMAH STREET
PORTLAND, OREGON 97232

December 6, 1978

In reply refer to:
(AFA-SE, 1-1-78-F-19)

Colonel Gwynn A. Teague
District Engineer
Department of the Army
Los Angeles District, Corps
of Engineers
P.O. Box 2711
Los Angeles, California 90053

Dear Colonel Teague:

Thank you for your letter of November 6 which was followed up with your request of November 22 for reinitiation of the Section 7 consultation on the Los Angeles Harbor deepening project. We are glad to learn that you discussed project modifications with the California Department of Fish and Game and NMFS. We look forward, too, to discussions regarding safeguarding least tern nesting habitat on Reeves Field.

Careful consideration will be given to the new proposal you developed which includes modifications to conserve the least tern. We will respond as quickly as possible to your reinitiation proposal. Likewise, we will work with the Harbor Department to develop a master plan for the Port of Los Angeles to assure minimum adverse impacts on the marine environment.

It should be pointed out the Endangered Species Act Amendments of 1978 require biological assessments accompanying Section 7 consultation requests involving construction projects. We will honor your request for this consultation

without an assessment based on the fact this is a reinitiation of a consultation that preceded the newly amended Section 7. However, we point out that the exemption process requires a biological assessment.

Sincerely yours,

R. Kahler Martinson
R. Kahler Martinson
Regional Director

United States Department of the Interior

FISH AND WILDLIFE SERVICE
LLOYD 500 BUILDING, SUITE 1692
500 N.E. MULTNOMAH STREET
PORTLAND, OREGON 97232

3 APR 1979

In reply refer to:
AFA-SE (1-1-78-F-19)

District Engineer
Los Angeles District
Corps of Engineers
P.O. Box 2711
Los Angeles, California 90053

Dear Sir:

This is in response to your request of November 22, 1978, for reinitiation of consultation pursuant to Section 7 of the Endangered Species Act of 1973, as amended by Public Law 95-632. The project under consideration involves the proposed disposal of dredge spoils within a 190-acre marine site located on the south side of Terminal Island, Los Angeles Harbor, Los Angeles, California (Enclosure 1). At issue is the impact of the proposed project upon the continued existence of the endangered California least tern (Sterna albifrons browni).

Information upon which this opinion is based was obtained from both verbal and written sources, as cited, and from onsite field investigations carried out by personnel of our Laguna Niguel Field Office. Our understanding of the project design is based on verbal communication with Mr. Dan Muslin, Project Engineer for the Corps of Engineers (CE) and from data contained in the CE Environmental Impact Statement on the Harbor Deepening Project. Additional information regarding project modifications and proposals was obtained from CE letters dated January 10, 1978, November 22, 1978, and during the meeting of January 16, 1978. Consultation on this project was first initiated by your letter of January 10, 1978. Numerous onsite visits and field sampling trips were conducted by the Fish and Wildlife Service (FWS)

between February and August 1978. The Service issued its Threshold Examination on March 23, 1978 and a Biological Opinion on Sepember 27, 1978 (Enclosure 2). This opinion stated that the project, as proposed, was likely to jeopardize the continued existence of the endangered least tern.

In an effort to find means to modify the project so as to preclude jeopardizing the continued existence of the least tern, the CE and the FWS met in Portland, Oregon, on October 25, 1978. As a result of this meeting, the Corps carried out further discussions with the California Least Tern Recovery Team, the National Marine Fisheries Service (NMFS), and the California Department of Fish and Game (CDFG), as outlined in the November 22 letter (Enclosure 3) and arrived at the modified proposal presented on page 3 of said letter.

Our preliminary review of the proposal revealed that, while it did provide some mitigation of project impacts, it still did not provide adequate measures to insure the survival of the least tern. Subsequent staff discussions on February 6, 1979, at the CE office in Los Angeles between Mr. Dan Muslin and Mr. Howard Lieberman of the CE, Mr. Calvin Hurst and Mr. Don Rice of the Port of Los Angeles (POLA), and Mr. Maeton Freel and Mr. Jack Fancher of the FWS, led to a meeting on February 16, 1979 in Los Angeles. Discussions at this meeting led to a number of recommended actions which the Service believes would eliminate any adverse impact on the least tern and provide adequate protection.

The California least tern is a migratory bird generally occupying its breeding area from April through August. The majority of birds nest along the coast of southern California from southern Santa Barbara County through San Diego County. Nesting activities of the terns have been monitored by the CDFG and members of the California Least Tern Recovery Team since 1970.[1] These nesting census studies indicate that the Terminal Island area has been utilized continuously since 1973. In 1973 and 1974, Reeves Field was successfully utilized as a nesting site by 14 nesting pairs of least terns.[2,3] This successful nesting was aided by the Los Angeles Police Department which provided protection of the nesting site from disturbance. The terns had also been observed in courtship flights over the Ferry Street area of Terminal Island but were prevented from nesting there due to grading and landfill activities.[2,3]

In 1975, the terns were prevented from using the Reeves Field site due to its use as a parking lot for cars. Fortunately, the Ferry Street site was not under construction pressure that year and terns were able to successfully nest there. There were a total of 40 nests established at the Ferry Street site during 1975.[4] In 1976, the Ferry Street site was not usable due to over-vegetation and disturbance by helicopter training flights.[5]

The Reeves Field site was open for use and undisturbed that year, so that by May there were 49 nests present and by June 29, there were an additional 25 more nests present. Fledgling success was good with over 50 juveniles counted. Least terns returned to the Reeves Field site in 1977; however, the Ferry Street site remained unsuitable for nesting due to heavy vegetative growth and storage of petroleum coke in the area.[6] The 1977 season at Reeves Field was very successful with 80 young fledgled from 85 nests. This represented the third largest nesting site in the state and the second highest fledgling count for the 1977 season.

The 1978 season found no nesting at either the Ferry Street or Reeves Field sites. The reasons behind this total lack of nesting area are not fully clear. No birds were ever observed courting over the Ferry Street site; however, courtship flights did occur over the Reeves Field site in typical pre-nesting behavior. Unfortunately, disturbance of the site at this critical period appears to have been enough to cause abandonment of the Reeves Field site for 1978.

As can be seen, the importance of the Terminal Island least tern colony is clearly evident and has steadily increased over the 5 years previous to 1978. There was a sixfold increase in the number of nests, and in 1977 the number of fledglings rose to almost 20 percent of the state's total production.

Since it was not possible to implement the Service's request for a detailed feeding study of the Terminal Island least tern colony in 1978, we have based this opinion on past observations and the statewide feeding study conducted in 1978 by the CDFG, as agreed to by all parties[8,9].

Data covering least tern foraging in Los Angeles Harbor consists of past census survey observations,[10,11,12] unpublished field observations in Los Angeles Harbor,[14,15] and the 1978 Statewide Feeding Study[16].

Review of available information indicates that nearshore, shallow water areas (less than 20 feet depth) in close proximity (1/2 - 3/4 mile) to the Terminal Island nesting sites are the primary feeding areas utilized by least terns nesting on Terminal Island.

The areas of highest usage during the past 5 years include the Seaplane Basin, shallow water area lying east and south of the Ferry Street nest site (the proposed fill area), and Fish Harbor. Several factors appear to influence the use of these areas. First, they comprise the major portion of the remaining shallow water (less than 20 feet deep) in Los Angeles Harobr. In observations of every other least tern colony in California, adults were found to prefer shallows or simulated shallow areas.(16) The 1978 data also suggests that the various wrecks located along the northwest section of the proposed fill area may also serve to attract prey fish utilized by the least tern.(14)

Second, present data indicates that the area of the proposed fill is undergoing a recovery in water quality and benthic life and is increasing as a feeding area for various fish and fish eating species of birds.(15) Large rafts of surf scoters have become almost constantly present. These birds feed on various shellfish and thus provide an indirect measure of the presence of plankton which is utilized as a food source of the shellfish and by several of the bait fish on which the least tern feeds.

Finally, these feeding areas are directly adjacent to the Reeves Field and Ferry Street nesting sites which is a vital factor in nest site selection during the period of feeding young and fledglings. Nest site selection is related to presence of adjacent feeding areas.

Knowing the importance of the Terminal Island colony and being cognizant of the above information, the California Least Tern Recovery Team has identified approximately 300 acres of Terminal Island and 500 acres of adjacent Los Angeles Harbor waters as essential habitat.(7) Approximately 95 percent of the fill area would lie within the boundaries of this habitat.

Based on the above information, it is the opinion of the Fish and Wildlife Service that the proposed project will not likely jeopardize the continued existence of the California least tern provided condition one or two listed below are implemented, as discussed at the February 16 meeting. (It should be noted that if these conditions are not implemented, the proposed project would likely jeopardize the continued existence of the California least tern):

1. The dredged material from deepening the harbor be disposed of at sea, at a location within the harbor in a manner that would not adversely impact the least tern

(reinitiation of consultation necessary), or at an upland site (reinitiation may be necessary); or

2. If these are not feasible and the fill must be placed in the harbor in such a manner that would impact the least tern, then the following conditions should be met to prevent jeopardy:

    a. Protect and maintain the existing 15-acre Reeves Field site for at least the 1979 and 1980 nesting seasons (April 1-August 31);

    b. After the 1980 nesting season the Reeves Field site could be relocated to an adjacent area with at least a one-third overlap of the 1977 nesting area for a minimum of two nesting seasons. Any subsequent relocations on Reeves Field area will also require one-third overlap of the most recent successful nesting area;

    c. The 15-acre Ferry Street site or a 15-acre site mutually acceptable to FWS and CE will need to be provided, protected, and maintained beginning with the 1982 nesting season for a minimum of 4 years, or until the new fill site has been utilized for nesting for at least 2 consecutive years, whichever comes first;

    d. Provide, protect, and maintain a 15-acre site on the new landfill for at least 4 years from the date the new fill area is mutually agreed to be suitable for nesting. Mutual agreement is to be between the CE and FWS;

    e. If no terns have nested at Reeves Field for 4 consecutive years, beginning with the 1979 season, the area may be relinquished providing a suitable alternate site is available for at least 4 additional years. The suitable alternate site will be mutually agreed to by FWS and CE and will be protected and maintained by CE;

    f. If the least terns nest for 2 consecutive years on both the Reeves Field and Ferry Street (alternate) sites, either site may be relinquished upon mutual agreement by FWS and CE and the other will be protected and maintained for nesting;

g. The existing Reeves Field site must be protected and maintained for a minimum of 2 years without attempting any movement to an adjacent area;

h. Any alternate site could be relinquished upon mutual agreement by FWS and CE after 4 consecutive years of nonnesting, or when another alternate site has had 2 consecutive years of successful nesting;

i. Protected sites, suitable for nesting, need only be protected during the nesting season (April 1-August 31) and maintenance will occur prior to least tern arrival for nesting (April 1);

j. Should any site become the only site utilized for nesting, this site will be protected and maintained in perpetuity or until such time as no nesting occurs for 4 consecutive years and it is mutually agreed to by CE and FWS that protection and maintenance measures can be abandoned;

k. The size of the landfill shall be a maximum of 190 acres;

l. Shallower water habitat (less than 20 feet) within the area bounded on the west by the landfill, on the north by the seaplane anchorage breakwater, on the east by a line immediately west of the port boundary, and on the south by a line protected from the south side of the landfill east to the port boundary will be provided. A detailed design for the placement of dredged material to create this shallower water habitat will be agreed upon by the CE and FWS prior to implementation of the project; and

m. As proposed by the District, CE will fund studies of the Terminal Island colony of least terns for a period of 7 years. Funding amounts and study plans are to be agreed upon prior to implementation of the project. If during any of the 7 years, no nesting occurs on Terminal Island, the funds allocated for that year's study may be utilized to study other least tern colonies in an effort to gain further information necessary to help conserve the species.

> In summary, any least tern nesting site shall be maintained until either: 1) no nesting has occurred for 4 consecutive years; or, 2) successful nesting has occurred at a nearby alternate site for 2 consecutive years and relinquishment is mutually agreed to by FWS and CE. Any subsequently established alternate nesting site shall also be protected and maintained as above. Site configuration, substrate preparation, and timing of activities within and immediately around such sites are to be mutually agreed to by the CE and FWS.

We would also like to emphasize that the Corps of Engineers, as well as all other Federal agencies, have the responsibility, pursuant to Section 7 of the Endangered Species Act, to utilize their authorities to carry out programs for the conservation of endangered and threatened species. This objective can be further achieved in connection with this project authority by:

1. Further reducing the acreage of the proposed fill and/or increasing shallow water habitat for tern feeding area;

2. Constructing artificial least tern feeding ponds that are stocked with mosquito fish (*Gambusia* spp.) on the new fill or other appropriate areas (to increase availability of food used by tern);

3. Placing an opening in the jetty along the western end of the seaplane anchorage to improve water quality and subsequently fisheries values (to increase availability of food used by terns);

4. Prepare and protect a 15-acre Ferry Street site for the 1979 and 1980 nesting seasons; and

5. Constructing isolated 1-2 acre islands within the harbor which could serve as additional least tern nesting areas.

This concludes our consultation on the Los Angeles Harbor Deepening Project. However, should any modifications other than those discussed above be considered, or should new

3 APR 1979

Page eight

information become available concerning the subject species, or if new species become listed that occur in the project area, CE should reinitiate consultation. We would appreciate notification of your intent on this project, in light of this opinion.

Sincerely yours,

R. Kahler Martinson

Regional Director

Enclosures

REFERENCES

(1) Craig, Alan. 1970. Survey of California least tern nesting sites. Report to the Resources Agency, Cali-Department of Fish and Game.

(2) Bender, Kristen. 1973. California least tern census and nesting survey, 1973. A report to the Resources Agency, California Department of Fish and Game.

(3) Bender, Kristen. 1974. California least tern population and nesting survey, 1974. A report to the Resources Agency, California Department of Fish and Game.

(4) Massey, Barbara. 1975. California least tern census and nesting survey, 1975. A report to the Resources Agency, California Department of Fish and Game.

(5) Bender, Kristen, E.B. Cooper, B. Massey and S.R. Wilbur. 1976. California least tern nesting survey, 1976. A report for the U.S. Fish and Wildlife Service and California Department of Fish and Game.

(6) Atwood, J.L., P.D. Jorgensen, R.M. Jurek and T.D. Manolis. 1977. California least tern census and nesting survey, 1977. A report for the Resources Agency, California Department of Fish and Game.

(7) California Least Tern Recovery Team. 1977. California Least Tern Recovery Plan, 1977, as amended. A report to the U.S. Fish and Wildlife Service, Portland, Oregon.

(8) Letter of July 26, 1978 from Lieutenant Colonel Robert H. Reinen, Acting District Engineer, Corps of Engineers, Los Angeles District, to Regional Director, U.S. Fish and Wildlife Service, Portland, Oregon.

(9) Crawford, Fred B. 1978. Personal communication at third Wildlife Workshop conducted by Los Angeles Harbor Department on August 17, 1978.

(10) Massey, Barbara W. 1978. Summary memo on observed feeding least terns in Los Angeles Harbor during 1975-76.

(11) Mulligan, Michael J. 1978. Memo concerning least tern observations at Reeves Field during 1976-1977.

(12) Atwood, John. 1978. Memo on least tern foraging activity Terminal Island area.

(13) Allan Hancock Foundation. 1976. Unpublished observations of least tern utilization of Los Angeles Harbor collected by Allan Hancock Foundation, University of Southern California 1973-1976 under U.S. Army Corps of Engineers Contract Number DACW09-73-0112.

(14) Hay, Douglas B. 1978. A preliminary report of the foraging behavior and ecology of the California least tern with respect to Los Angeles Harbor. Prepared for the U.S. Fish and Wildlife Service and California Department of Fish and Game, September 1978.

(15) U.S. Fish and Wildlife Service. 1978. Resource analyses and observations of avian use of portions of Los Angeles Harbor. Field data collected by the Laguna Niguel Field Office, 1978.

(16) California Department of Fish and Game. 1978. Draft Statewide Feeding Study of the California least tern, 1978.

September 27, 1978

In reply refer to:
AFA-SL (1-1-78-F-19)

Colonel Gwynn A. Teague
District Engineer
Los Angeles District
Corps of Engineers
P.O. Box 2711
Los Angeles, California 90053

Dear Colonel Teague:

This letter is in further response to your request dated January 10, 1978, requesting formal consultation on the proposed Los Angeles Harbor Interim Project, Los Angeles County, California.

Our earlier threshold examination statement was submitted to you on March 23, 1978. In this statement, we indicated that additional information was required before we could issue our biological opinion on the project. Part of the information required was a site specific feeding study of the Terminal Island least tern colony. However, due to several unfortunate disruptive activities at the Terminal Island site, the terns chose not to nest there this year. Therefore, a detailed feeding study of the site became impossible this year and would require at least another year's delay to obtain. As an alternative to this further delay, it was agreed upon by the Corps of Engineers and the Port of Los Angeles that utilization of existing information and the results of the California Department of Fish and Game's 1978 Statewide Feeding Study of least terns would serve as acceptable criteria upon which our biological opinion would be based.

We have reviewed the existing information concerning the Terminal Island nesting site, and the 1978 Statewide Feeding

September 27, 1978

In reply refer to:
AFA-SE (1-1-78-F-19)

Colonel Gwynn A. Teague
District Engineer
Los Angeles District
Corps of Engineers
P.O. Box 2711
Los Angeles, California 90053

Dear Colonel Teague:

This letter is in further response to your request dated January 10, 1978, requesting formal consultation on the proposed Los Angeles Harbor Interim Project, Los Angeles County, California.

Our earlier threshold examination statement was submitted to you on March 23, 1978. In this statement, we indicated that additional information was required before we could issue our biological opinion on the project. Part of the information required was a site specific feeding study of the Terminal Island least tern colony. However, due to several unfortunate disruptive activities at the Terminal Island site, the terns chose not to nest there this year. Therefore, a detailed feeding study of the site became impossible this year and would require at least another year's delay to obtain. As an alternative to this further delay, it was agreed upon by the Corps of Engineers and the Port of Los Angeles that utilization of existing information and the results of the California Department of Fish and Game's 1978 Statewide Feeding Study of least terns would serve as acceptable criteria upon which our biological opinion would be based.

We have reviewed the existing information concerning the Terminal Island nesting site, and the 1978 Statewide Feeding

Study conducted by the California Department of Fish and Game, and are now prepared to provide our biological opinion, as prescribed by the "Interagency Cooperation Regulations" for the Endangered Species Act of 1973 issued in the J January 4, 1978 Federal Register.

The Fish and Wildlife Service (FWS) is of the opinion that the project, as presently proposed, is likely to jeopardize the continued existence of the endangered California Least Tern by reducing the likelihood of their recovery through direct and indirect impacts of the proposed project.

The California Least Tern is a migratory bird generally occupying its breeding area from April through August. The majority of birds nest along the coast of southern California from southern Santa Barbara County south through San Diego County. Nesting activities of the terns have been monitored by the California Department of Fish and Game (CDFG), and members of the California Least Tern Recovery Team since 1970.1/ These nesting census studies indicate that the Terminal Island area has been utilized continuously since 1973. In 1973 and 1974, the Reeves Field site was successfully utilized as a nesting site by 14 nesting pairs of least terns.2/3/ This successful nesting was aided by the Los Angeles Police Department which provided protection of the nesting site from disturbance. The terns had also been observed in courtship flights over the Ferry Street area of Terminal Island, but were prevented from nesting there due to grading and landfill activities.2/3/

In 1975, the terns were prevented from using the Reeves Field site due to its use as a parking lot for imported cars. Fortunately, the Ferry Street site was not under construction pressure that year and terns were able to successfully nest there. There was a total of 40 nests established at the Ferry Street site during 1975.4/ In 1976, the Ferry Street site was not usable due to the presence of unsuitable plant growth and disturbance by helicopter training flights.5/ The Reeves Field site was left undisturbed that year and by May, 49 nests were present; by June 29, there were 25 more. Fledging success was good with 50+ juveniles counted. Least terns returned to the Reeves Field site in 1977; however, the Ferry Street site remained unsuitable for nesting due to heavy vegetation growth and storage of petroleum coke in the area.6/ The 1977 season at Reeves Field was very successful with 80 young fledged from 85 nests. This represented the third

largest nesting site in the state and the second highest fledging count for the 1977 season.

The 1978 season found no nesting at either the Ferry Street or Reeves Field sites. The reasons behind this total lack of nesting are not fully clear. No birds were observed courting over the Ferry Street site; however, courtship flights did occur over the Reeves Field site in typical prenesting behavior. Unfortunately, disturbance of the site at this critical period appears to have been enough to cause abandonment of the Reeves Field site for 1978.

As can be seen, the importance of the Terminal Island least tern colony is clearly evident and has steadily increased over the past 5 years. There has been a sixfold increase in the number of nests, and in 1977 the number of fledglings had risen to almost 20 percent of the state's total production.

As discussed earlier, our request for a detailed feeding study of the Terminal Island least tern colony was not possible this year; therefore, as agreed to by all parties,8/9/ we have based our information on past observations and the statewide feeding study conducted this year by the CDFG.

Data covering least tern foraging in Los Angeles Harbor consist of past census survey observations10/11/12/, unpublished field observations of the 1973-1976 Allan Hancock Foundation13/, 1978 observations in Los Angeles Harbor14/15/ and the 1978 Statewide Feeding Study16/.

Review of available information indicates that the nearshore, shallow water (less than 20 feet depth) areas in close proximity (1/2-3/4 mile) to the Terminal Island nesting sites are the primary feeding areas utilized by the least tern when nesting on Terminal Island. The areas of highest usage during the past 5 years include the Seaplane Basin, shallow water area lying east and south of the Ferry Street nest site (the proposed fill area) and Fish Harbor. Several factors appear to influence the use of these areas. First, these areas comprise the major portion of the remaining shallow water (less than 20 feet) area of Los Angeles harbor. In observations of every other least tern colony in California, adults were found to prefer shallows or simulated shallow areas.16/ The 1978 data also suggest that the various wrecks located along the northwest section of the proposed fill area may also serve to attract prey fish utilized by the terns.14/

Second, present data indicate that the area of the proposed fill is undergoing a recovery in water quality and benthic life and is improving in its value as a feeding area for various fish and fish eating species of birds.15/ In addition, large rafts of Surf Scoters have become almost constantly present. These birds feed on various shellfish and thus provide an indirect measure of the presence of plankton which is utilized as a food source of the shellfish, and by several of the bait fish on which the least tern feeds.

Finally, this feeding area is directly adjacent to the Reeves Field and Ferry Street nesting sites. The feeding area is vital to the terns during the period in which they feed their young.

Based on the importance of the Terminal Island colony and being cognizant of the above information, the Least Tern Recovery Team has recommended approximately 300 acres of Terminal Island and 500 acres of adjacent Los Angeles Harbor waters as candidate areas for a critical habitat determination.7/ Approximately 95 percent of the fill area would lie within the boundaries of this candidate critical habitat.

As presently proposed, the fill project would destroy approximately 40 percent of the feeding area identified as essential to the existence of the Terminal Island least tern colony. In addition, there are neither provisions provided which compensate for the direct loss of feeding area, nor that provide any protection of the known Reeves Field or Ferry Street nesting sites nor any nesting sites which may be established on the new fill site.

Based on the above discussion, the opinion of the Fish and Wildlife Service regarding impacts on endangered species by the presently proposed Los Angeles Harbor Interim (fill) Project is that the continued existence of the endangered California Least Tern will be jeopardized. This letter finalizes your consultation requested on January 10, 1978.

Though this consultation is now completed, interagency cooperation regulations allow for reinitiation of a consultation if new information is forwarded, or the activity

or project is subsequently modified. It is under this latter condition we believe the Corps could reinitiate consultation based on the following or similar recommendations:

1. The proposed fill be disposed of at sea or so located within the harbor such that it would not adversely impact the endangered least tern.

2. The Reeves Field and Ferry Street nesting sites be protected and maintained as nesting sites until such time that they may become permanently abandoned for new nesting sites established by the terns elsewhere in Los Angeles Harbor.

3. Provisions be made to protect any new nesting sites that may become established on the proposed fill area or elsewhere in Los Angeles Harbor.

4. Compensation, in the form of habitat replacement, be included in the project to make up for the loss of feeding area that would result from the fill project.

5. Any other such measure that would result in a net neutral or beneficial impact upon the least tern.

These above recommendations are not all inclusive and further analyses by both our staffs could modify these recommendations and/or may lead to additional recommendations.

We would appreciate notification of your intent in light of this opinion and the above discussion.

Sincerely yours,

William E. Meyer

Enclosure

Acting Regional Director

cc: Area Manager, Sacramento, CA

W White/DBMarshall:imb
cc: AE

REFERENCES

(1) Craig, Alan. 1970. Survey of California least tern nesting sites. Report to the Resources Agency, California Department of Fish and Game.

(2) Bender, Kristen. 1973. California least tern census and nesting survey, 1973. A report to the Resources Agency, California Department of Fish and Game.

(3) Bender, Kristen. 1974. California least tern population and nesting survey, 1974. A report to the Resources Agency, California Department of Fish and Game.

(4) Massey, Barbara. 1975. California least tern census and nesting survey, 1975. A report to the Resources Agency, California Department of Fish and Game.

(5) Bender, Kristen, E.B. Cooper, B. Massey and S.R. Wilbur. 1976. California least tern nesting survey, 1976. A report for the U.S. Fish and Wildlife Service and California Department of Fish and Game.

(6) Atwood, J.L., P.D. Jorgensen, R.M. Jurek and T.D. Manolis. 1977. California least tern census and nesting survey, 1977. A report for the Resources Agency, California Department of Fish and Game.

(7) California Least Tern Recovery Team. 1977. California Least Tern Recovery Plan, 1977, as amended. A report to the U.S. Fish and Wildlife Service, Portland, Oregon.

(8) Letter of 26 July 1978 from Leiutenant Colonel Robert H. Reinen, Acting District Engineer, Corps of Engineers, Los Angeles District, to Regional Director, U.S. Fish and Wildlife Service, Portland, Oregon.

(9) Crawford, Fred B. 1978. Personal communication at third Wildlife Workshop conducted by Los Angeles Harbor Department on August 17, 1978.

(10) Massey, Barbara W. 1978. Summary memo on observed feeding of least terns in Los Angeles Harbor during 1975-1976.

(11) Mulligan, Michael J. 1978. Memo concerning least tern observations at Reeves Field during 1976-1977.

(12) Atwood, Jan. 1978. Memo on least tern foraging activity, Terminal Island area.

(13) Allan Hancock Foundation. 1976. Unpublished observations of least tern utilization of Los Angeles Harbor collected by Allan Hancock Foundation, University of Southern California 1973-1976 under U.S. Army Corps of Engineers Contract Number DACW09-73-0112.

(14) Hay, Douglas B. 1978. A preliminary report of the foraging behavior and ecology of the California least tern with respect to Los Angeles Harbor. Prepared for the U.S. Fish and Wildlife Service and California Department of Fish and Game, September 1978.

(15) U.S. Fish and Wildlife Service. 1978. Resource analyses and observations of avian use of portions of Los Angeles Harbor. Field data collected by the Laguna Niguel Field Office, 1978.

(16) California Department of Fish and Game. 1978. Draft Statewide Feeding Study of the California least tern, 1978.

DEPARTMENT OF THE ARMY
LOS ANGELES DISTRICT, CORPS OF ENGINEERS
P. O. BOX 2711
LOS ANGELES, CALIFORNIA 90053

SPLED-CW

22 November 1978

Mr. Kahler Martinson
Regional Director
U.S. Fish and Wildlife Service
Lloyd 500 Building, Suite 1692
500 N.E. Multnomah Street
Portland, Oregon 97232

Dear Mr. Martinson:

This letter is in response to your Section 7 report on the Los Angeles Harbor deepening project and to marine habitat issues discussed at the meeting held in your office on 25 October 1978. A copy of our memorandum of this meeting was provided to your office with our letter of 6 November 1978. This memorandum outlined the understandings and directions that we can take with the Section 7 proceedings. I feel, and hope you will concur, that the Section 7 consultation should be reinitiated based on the proposed modifications outlined in this letter.

Personnel of the Los Angeles District have met with James Slawson, National Marine Fisheries Service (NMF); Dick Nitsos, California Department of Fish and Game (Cal F&G); Dr. Charles Collins, Paul Kelly, Barbara Massey, Kristen Bender, John Atwood, Ron Jurek, and Alan Craig, members of, or consultants for, the Least Tern Recovery Team; and officials of the Los Angeles Harbor Department. On the basis of these meetings, we are proposing modifications to compensate for loss of marine habitat and possible effects on the California least tern. The proposals of NMF/Cal F&G, the consensus of the recovery team members and consultants, and our proposal, which was developed in good faith with the Harbor Department, are presented in the following paragraphs.

The NMF/Cal F&G proposal for compensation for loss of marine habitat consisted of creating shallower water habitat east of the proposed fill by placing sand on the area to form a sloping bottom. Their proposal also included a reduction in acreage of the landfill from 200 to 175 acres and an associated habitat replacement. It is recognized that marine fisheries interests would like to see the size of the fill area reduced further, if not totally eliminated. We can sympathize with this view as it relates to the preservation of marine habitat. However, as emphasized to you at our 25 October meeting, further substantive reduction in size of the fill area is not feasible.

SPLED-CW 22 November 1978
Mr. Kahler Martinson

The main objective of the Least Tern Recovery Team was the maintenance of a least tern colony on Terminal Island. Recovery team members and consultants provided the District with five proposals, outlined in the following paragraphs as proposals A through E. In all proposals, they indicated the unwillingness to relinquish an active nesting area until the terns had either deserted it or moved to another site.

Proposal A consists of the following elements:

a. Maintain the existing fence around the approximately 15-acre Reeves Field nesting site through the 1979 nesting season.

b. Prepare (to the specifications of the recovery team) and maintain (until the landfill is suitable for nesting-approximately 4 years) a 15-acre nesting site in the Ferry Street site area for the purpose of establishing this as the new nesting site. This would make the Reeves Field site available for use by the Harbor Department. The proposed Ferry Street site would be used as an experiment to gather data on methods of establishing nesting habitat.

c. Provide and maintain, until further compensation proposals are implemented for future harbor expansion, a similar 15-acre site on the landfill as a new site, allowing the harbor to utilize the Ferry Street site.

Proposal B consists of the following elements:

a. Maintain the fence and 15-acre Reeves Field nesting site until the landfill is suitable for nesting (approximately 4 years).

b. Provide a nesting site as outlined in "c" above.

Proposal C consists of maintaining the Reeves Field site until other plans could be implemented or until the least tern no longer nests on Terminal Island.

Proposal D contains the following elements:

a. Maintain the fence and Reeves Field nesting area to the specifications of the recovery team until completion of the project (no more than 4 years).

b. Construct, prepare, and maintain two 1-acre islands east of the landfill to the recovery team's specifications for nesting, making the Reeves Field site available for use by the Harbor Department.

Proposal E contains the following elements:

a. Relocate the landfill to the southeast by approximately 1,000 feet, forming an island and reducing the impact on shallow water habitat.

b. Implement proposal D.

We presented all of these proposals to the Harbor Department. On the basis of these proposals and discussions with Harbor Department officials, I recommend the following proposals which I believe compensate for the loss of marine habitat and ensure the continued existence of the least tern. The proposals are based on the assumption that the least terns nest on the sites provided. Two scenarios will need to be discussed in a future detailed proposal: first, if the terns do not return to nest or second, do not nest on the sites provided. The proposals are as follows:

a. Maintain the existing fence around the approximately 15-acre Reeves Field nesting site through the 1979 nesting season.

b. Prepare (to the specifications of the U.S. Fish and Wildlife Service) and maintain (until the landfill is suitable for nesting - approximately 4 years) a 15-acre nesting site in the Ferry Street site area for the purpose of establishing this as the new nesting site; this would make the Reeves Field site available for use by the Harbor Department. The proposed Ferry Street site would be used as an experiment to gather data on methods of establishing nesting habitat.

c. Provide and maintain, until further compensation proposals are implemented for future harbor expansion, a similar 15-acre site on the landfill as a new site, allowing the harbor to utilize the Ferry Street site.

d. Reduce the size of the landfill to 190 acres.

e. Provide shallower water habitat within the area bounded on the west by the landfill, on the north by the seaplane anchorage breakwater, on the east by a line west of the Port boundary, and on the south by a projected line from the south side of the landfill to the Port boundary.

f. Provide funds for studies of the Terminal Island colony nesting and feeding habitat that would start prior to the 1979 nesting season to determine the effectiveness of the proposals.

SPLED-CW 22 November 1978
Mr. Kahler Martinson

The additional costs of our recommended proposals will be borne by the Corps of Engineers and the Los Angeles Harbor Department. The Corps will provide the funds for the study through completion of the project, and the Harbor Department will provide the funds from completion of the project to completion of the study.

The U.S. Fish and Wildlife Service, the National Marine Fisheries Service, the California Department of Fish and Game, the Corps, and the Harbor Department will need to develop an agreement that provides details of the proposal and its implementation.

The concept of my proposals has the informal acceptance of personnel of the California Department of Fish and Game and the National Marine Fisheries Service and representatives of the Least Tern Recovery Team. Maintenance of the Reeves Field site and development of the Ferry Street site will require immediate action between your office and the Harbor Department to assure least tern nesting in 1979. Again, we hope that this plan meets with your approval so that we can proceed with the project with the knowledge that the continued existence of the California least tern will not be jeopardized. I look forward to your reply concerning this proposed modification plan.

Sincerely yours,

Gwynn A. Teague

GWYNN A. TEAGUE
Colonel, CE
District Engineer

SPLED-CW

15 May 1979

Mr. Kahler Martinson, Regional Director
U.S. Fish and Wildlife Service
Lloyd 500 Building, Suite 1692
500 N.E. Multnomah Street
Portland, Oregon 97232

Dear Mr. Martinson:

I have received your Section 7 report, dated 3 April 1979, addressing the impact the proposed Los Angeles harbor deepening project will have on the California least tern.

We agree to the conditions outlined in item "2" of your report and assure you that they will be met. We concur in your conclusion that the project would not jeopardize the continued existence of the least tern, assuming the conditions are implemented.

We are now ~~at~~ finalizing our plans and preparing our draft report and environmental impact statement. We plan on initiating formal coordination of these reports in July 1979 and anticipate construction starting in March 1980.

If you have any questions regarding our future plans, please do not hesitate to contact me.

Sincerely,

GWYNN A. TEAGUE
Colonel, CE
District Engineer

CF:
Mr. Jack Wells
General Manager
Port of Los Angeles
P.O. Box 151
San Pedro, CA 90731

APPENDIX C

REMOVAL AND RELOCATION OF UTILITIES

CONTENTS

REMOVAL AND RELOCATION OF UTILITIES

General. The Los Angeles Harbor Department has qualified itself as the local sponsoring agency for this project. Relocation of all utilities and dredging within the utility areas will be closely coordinated with the sponsoring agency during the project. A description of the utilities to be relocated, their locations, and a list of all the utilities has been provided by the Harbor Department.

ATTACHMENT A

PROJECT DESCRIPTION

This project provides for the removal, relocation, or replacement of existing submarine pipelines and cables crossing harbor channels at elevations less than -50 feet mean lower low water. These removals are necessary to provide an unobstructed clearance for the Corps of Engineers' dredging project to deepen Los Angeles Harbor.

Various methods may be required to accomplish the removals. Lines with little or no cover can be pulled, cut into sections, and hauled away. Deeply buried lines must be uncovered by bucket dredging and/or jetting. The dredged material will be disposed of on land or at an approved site at sea if the material complies with disposal requirements.

Relocated or replacement lines will be placed in dredged trenches with the top of line no higher than elevation -55 feet MLLW within the channel and then backfilled with an approved clean material to an elevation no higher than -48 feet MLLW.

It is the intent to confine removals and relocations in the limits of the existing utility corridors as shown on the enclosed drawings and described as follows:

Utility Corridor A - Shown on Drawing No. 5-4671-2

1. The Department of Water and Power will remove the existing 20" diameter water line at -45' MLLW from Berth 84 to 235. A new 30" diameter water line will be installed at -55' MLLW approximately 600 feet southerly crossing from Berth 83 to Berth 236.

2. The Department of Public Works and the Department of Public Utilities and Transportation will remove the existing 20" diameter abandoned sewer line housing communication cables at elevation -45' MLLW, crossing from Berth 84 to Berth 234.

Utility Corridor B - Shown on Drawing No. 5-4671-3

1. Western Union will remove an abandoned cable at elevation -45' MLLW crossing from Berth 100 to Berth 150.

2. Chevron U.S.A. will remove an abandoned 8" diameter oil pipeline at elevation -45' MLLW crossing from Berth 98 to Berth 150.

3. Pacific Telephone will remove three cables at elevation -45' MLLW, crossing from Berth 100 to Berth 149.

Utility Corridor C - Shown on Drawing No. 5-4671-4

1. The Department of Public Utilities and Transportation and the Harbor Department will remove two 4" diameter and one 6" diameter abandoned oil pipelines, one with a communication cable at -40' MLLW crossing from Berth 174 to Berth 218.

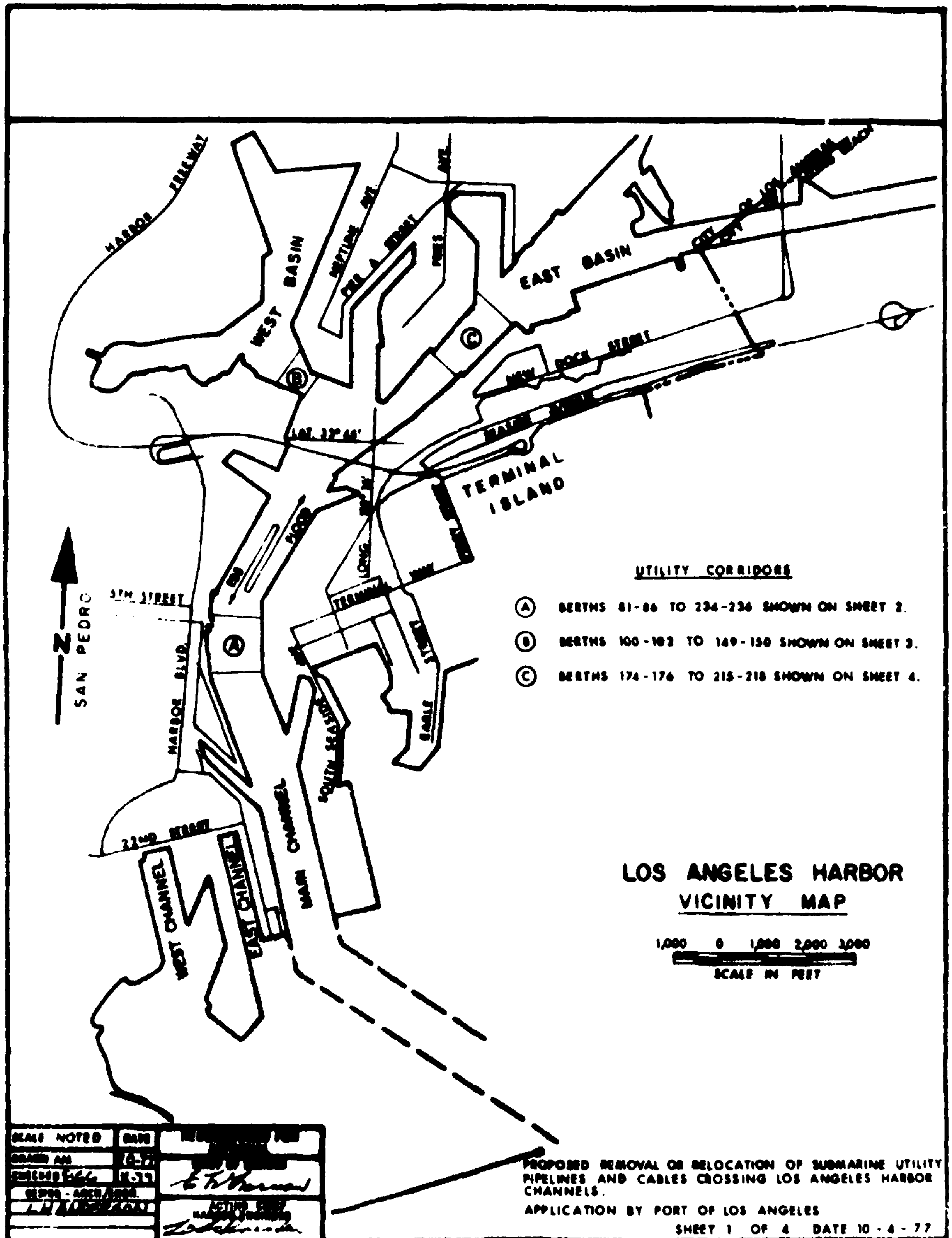
Utility Corridor C (cont'd.)

2. Mobil Oil Company will remove six 6" diameter and one 8" diameter oil pipelines at elevation -40' MLLW crossing from Berth 174 to Berth 218. These lines will be replaced with one 10" diameter and one 16" diameter pipeline at elevation -57' MLLW adjacent to Mobil's existing right of way crossing from Berth 176 to Berth 216.

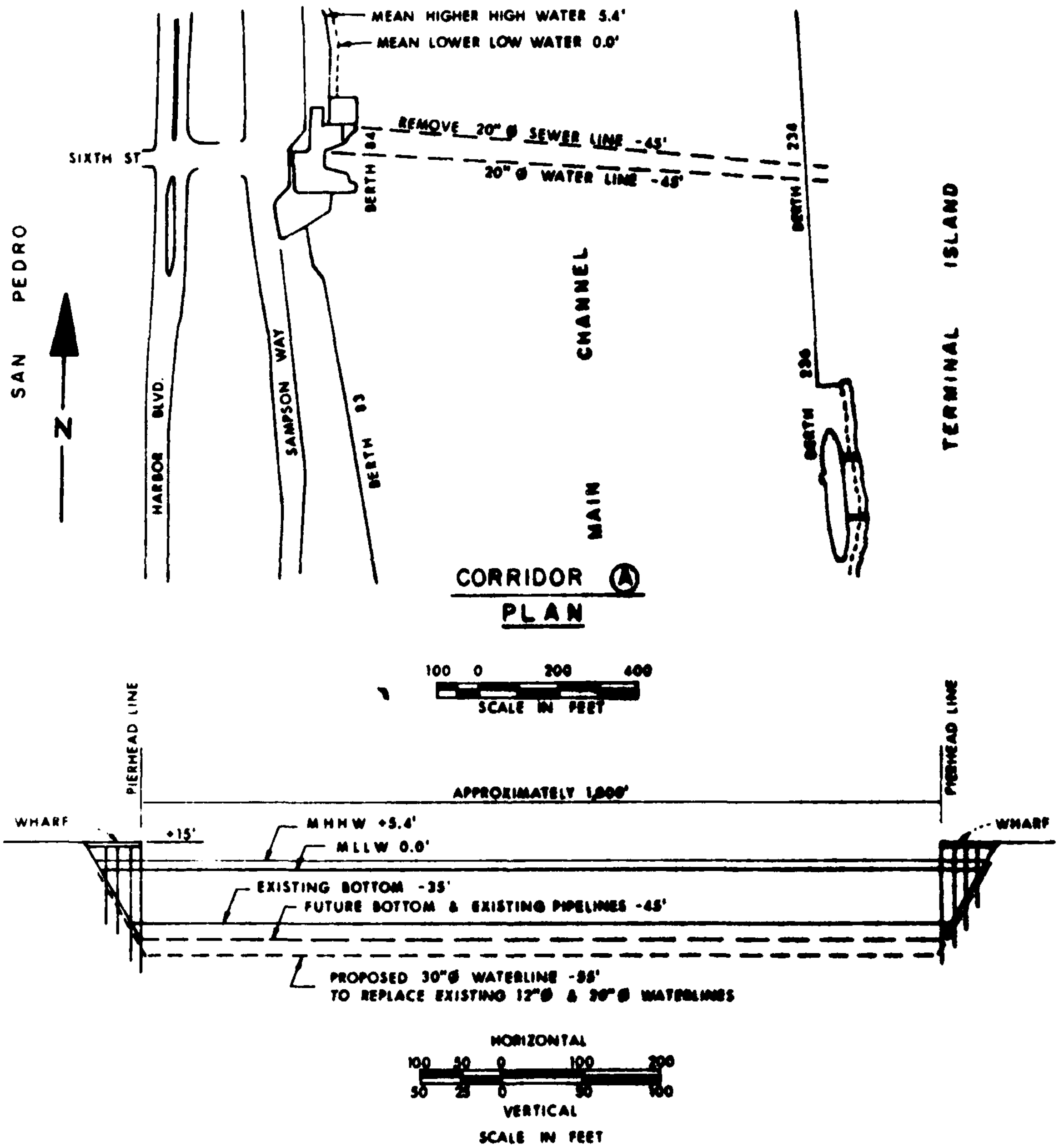
3. Pacific Telephone will remove one cable at elevation -40' MLLW crossing from Berth 174 to Berth 218.

4. The Department of Public Works will remove one 16" diameter abandoned sewer line at elevation -40 MLLW crossing from Berth 175 to Berth 218.

5. The Department of Water and Power will remove one 12" diameter water line at elevation -40 MLLW crossing from Berth 175 to Berth 218.



DWG. NO. 5-4671-1



DATUM: MEAN LOWER LOW WATER

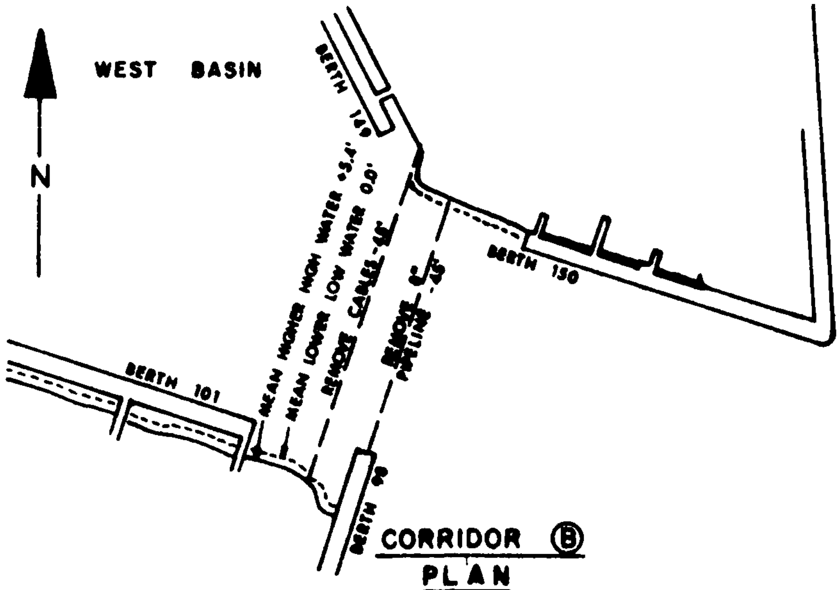
SCALE NOTED	DATE	RECOMMENDED FOR APPROVAL
DRAWN AM	10-77	CHIEF OF DESIGN
CHECKED D.G.C.	11-77	
DESIGN - ARCH/ENGR.		ACTING CHIEF HARBOR ENGINEER
[illegible]		

PROPOSED REMOVAL OR RELOCATION OF SUBMARINE UTILITY PIPELINES AND CABLES CROSSING LOS ANGELES HARBOR CHANNELS.

APPLICATION BY PORT OF LOS ANGELES

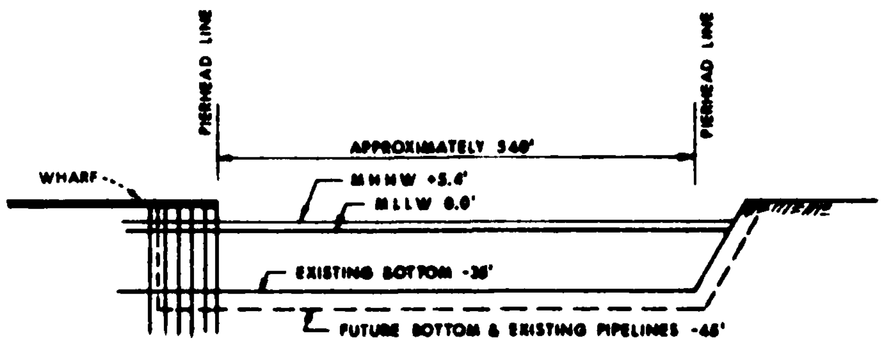
SHEET 2 OF 4 DATE 10-4-77

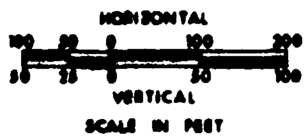
DWG. NO. 5-4671-2



CORRIDOR (B)

PLAN





DATUM: MEAN LOWER LOW WATER

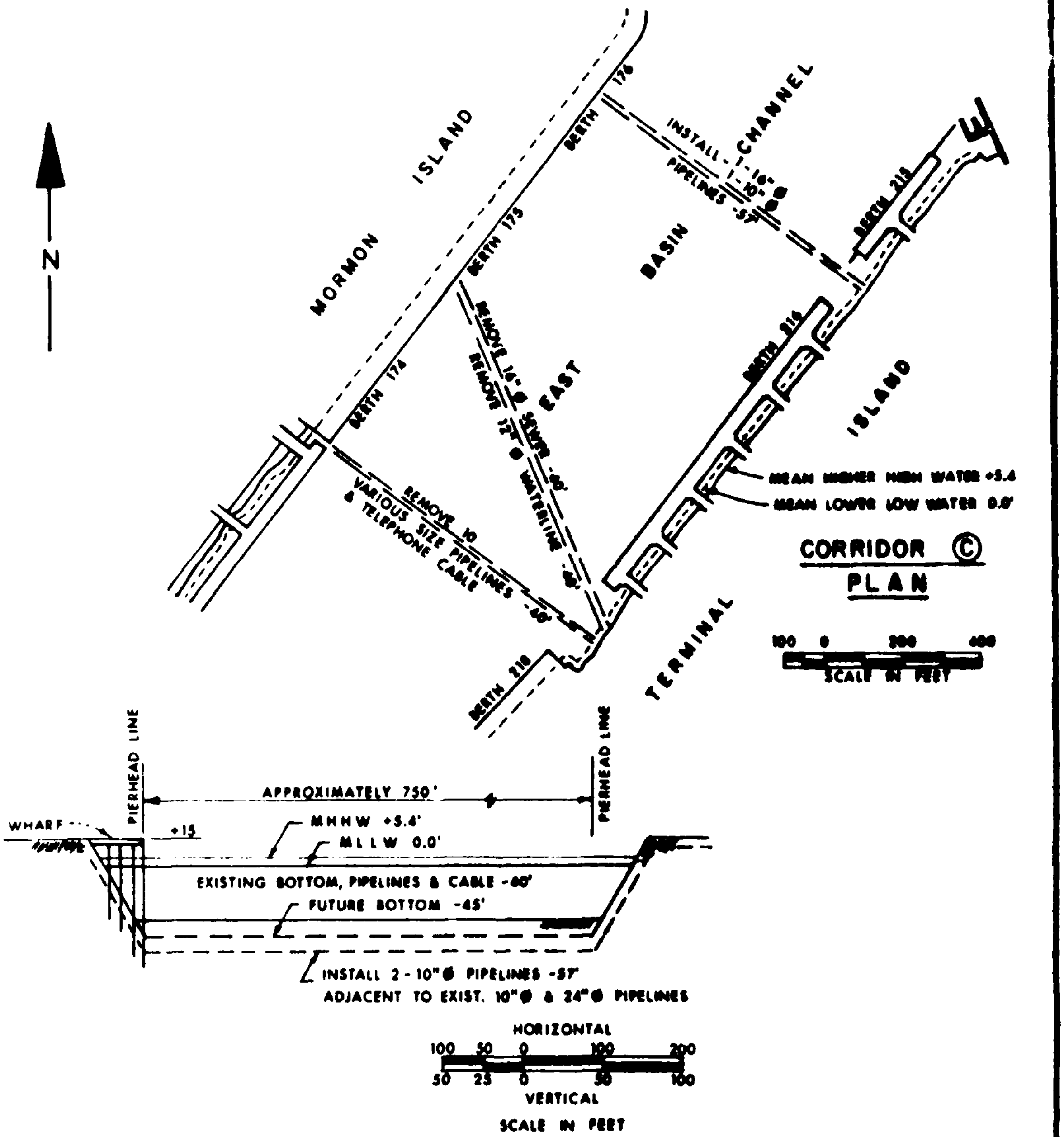
SCALE NOTED	DATE	RECOMMENDED FOR APPROVAL
DRAWN A.M.	10-77	
CHECKED	11-77	
		ACTING CHIEF HARBOR ENGINEER

PROPOSED REMOVAL OR RELOCATION OF SUBMARINE UTILITY PIPELINES AND CABLES CROSSING LOS ANGELES HARBOR CHANNELS.

APPLICATION BY PORT OF LOS ANGELES

SHEET 3 OF 4 DATE 10-4-77

DWG. NO. 5-4671-3



DATUM: MEAN LOWER LOW WATER

SCALE NOTED	DATE	RECOMMENDED FOR APPROVAL
DRAWN A.M.	10-77	CHIEF OF DESIGN
CHECKED D.G.C.	11-77	
DESIGN - ARCH/ENGR.		ACTING CHIEF HARBOR ENGINEER
L.H. ANDERSON		

PROPOSED REMOVAL OR RELOCATION OF SUBMARINE UTILITY PIPELINES AND CABLES CROSSING LOS ANGELES HARBOR CHANNELS.

APPLICATION BY PORT OF LOS ANGELES

SHEET 4 OF 4 DATE 10-4-77

DWG. NO. 5-4671-4

TABLE I

UTILITY AND PIPELINES CROSSING MAIN CHANNEL
Status Report as of July 1, 1978

Notes: a) * indicates line must be removed or relocated.

b) Reference Elevation 0.00 Feet Mean Lower Low Water (M.L.L.W.)

BERTH NO.	OWNER	DESCRIPTION	EXISTING ELEVATION AT TOP OF PIPE	OWNERS PRESENT PLANS IF KNOWN OR OUR COMMENTS
DREDGING AREA				
81-236	Mobil	36" ø pipeline	-50	(5)
84-235	Dept. Water & Power	20" ø water line	-45	(5) Draft agreement to allow line to remain sent by FBC Ltr. 5/24/78.
	Dept. Public Works	20" ø sewer	-45*	(1)
	Dept. Pub. Util. & Transportation	Communication cables in abandonded sewer line	-45*	(1) Draft agreement for Corps removal being prepared per FBC Ltr of 12/7/77
	Pacific Telephone	2 cables	-50	(5)
92-229	Pacific Telephone	1 cable	-50	(5)
100-149 & 150	Standard Oil	8" ø pipeline	-45*	MARMAC Systems Engineering preparing design drawings for removal.
	L.A.H.D.	12" ø pipeline	-51	Modification may be reqd. at S. side of W.Basin entrance.
	Western Union	Cable	-45*	Notified of legal responsibility to remove per FBC ltr. of 3/29/78.
	Pacific Telephone	3 cables	-45*	Verbally notified us that relocation can be done easily.
170-222	Dept. Public Works	20" ø sewer	-51	(5)

BERTH NO.	OWNER	DESCRIPTION	EXISTING ELEVATION AT TOP OF PIPE	OWNERS PRESENT PLANS IF KNOWN OR OUR COMMENTS
174-218	Mobil	Multiple pipelines	-40*	Meeting 3/15/77--Plans replacement in another R/W at Berths 176-215 prior to removing these lines.
	L.A.H.D.	Multiple pipelines	-40*	(3)
	Pacific Telephone	1 cable	-40*	Verbally notified us that relocation can be done easily.
	Dept. Water & Power	2 cables	-50	(5)
	Dept. Publ. Util. & Transportation	Communication cables in abandoned oil line	-40*	Draft agreement for Corps removal being prepared per FBC Ltr. 12/7/77.
175-218	Dept. Public Works	16" ø sewer	-40*	(1) Agreement being prepared.
	Dept. Water & Power	12" ø water line	-40*	Remove 12" line per ltr. 4/22/77. (1) (2)
176-215	Dept. Water & Power	Water line	-55	(5)
	Mobil	24" ø & 10" pipeline	-60	(5)
Angle's Gate at Breakwater Entr.	U.S. Coast Guard	Power & commun. cables	On bottom -45 to -52	(4) (5)
L.A. Channel Entrance	U.S. Coast Guard	Power cables	On bottom -35	(4)
East Basin	U.S. Coast Guard	Power cables	On bottom -20	(4)

BERTH NO.	OWNER	DESCRIPTION	TOP OF PIPE	OWNERS PRESENT PLANS IF KNOWN OR OUR COMMENTS
DISPOSAL SITE				
Pipeline and utility owners listed below have not been notified except for the L.A. City Department of Public Works. Changes in fill configuration may result in some of these pipelines and utilities clearing the fill project.				
Pier 301 East face	L.A.H.D.	18" ø Storm Drain	+10	Storm drain discharges which may be blocke the fill area may be provided temporary di charge through a temporary drainage ditch during the period of dredging and dredge f consolidation.
Pier 301 East Face	L.A.H.D.	66" ø Storm Drain		"
Pier 303 East face	U.S. Navy	49" ø Storm Drain	0	"
Pier 301	Star-Kist	30" ø Industrial Sewer	+5	Relocate or terminate discharge
Pier 301 East face	L.A.H.D.	42" ø Industrial Sewer		"
Pier 303 South face	Dept. Public Works	39" ø T.I.T.P. Outfall	On Bottom -15	To be extended to clear fill area
Navy Operating Area	U.S. Navy	2" Drain at Bldg. #584		Fill area and diking will not include this drain
		6" Storm Drain at Bldg. #569		"
		18" Storm Drain at Bldg.#569		"
		6" Storm Drain at Bldg. #571		"

BERTH NO.	OWNER	DESCRIPTION	TOP OF PIPE	OWNERS PRESENT PLANS IF KNOWN OR OUR COMMENTS
Navy Operating Area (Continued)		24" Storm Drain at Bldg. #616		Fill area and diking will not include this area.
		21" Storm Drain at Bldg. #576		
		18" Storm Drain at Bldg. #575(W)	▪	
		18" Storm Drain at Bldg. #575(E)	▪	
		21" Storm Drain at Bldg. #561	▪	
Navy Mole (West face)	U.S. Navy	Storm drain	▪	

(1) May request Corps to include removal in dredging contract as separate bid item.

(2) May combine removal with P.U. & T. line running in sewer.

(3) LARD lines in same area could be removed by Mobil contractor if agreement reached.

(4) U.S. Coast Guard has not been contacted. Location information is estimated from navigation chart.

(5) To remain in its present location.

LMA:cw
10/18/77

Berth Numbers	Utility	Size (Number)	Owner	Depth	Reference Drawing No.	Dwg. Date	Remarks
157-164	Oil Line	8"	Standard Oil	-45	7-207	3-59	
158-163	Oil Line	8"	Golden Eagle	-45	6827	6-13	
100-149	Telephone	3	Pacific Tel.&Tel.	-45	6-613	9-55	(9-524)
176-215/216	Water	24"	Dept. W. & P.	-55	9-082 6-395	11-48	Gen. Permit 14-1949
175-218	San. Sewer	16"	Dept. Public Works	-40	6547 6406	1924 8-21	
94/95-229	Power	2	Dept. W. & P.	-35 (bottom)	5-2985 2-1832	6-58	Gen. Permit 55-1958 Removed G.P. 18-1965
81-236	Oil Line	36"	Socony Mobil	-50	6-913-1	10-62	
100-150	Telegraph	1	Western Union	-45	2-1625	1-58	
174-218	Oil Lines	6-6"	Socony Mobil	-40	2896 9-399 2-1134	1-33 1959	 Gen. Permit 72-1959
174-218	Oil Lines	1-4"	Texaco	-40		3-28	Gen. Permit 431
174-218	Oil Line	1-6"	Texaco	-40		3-28	Gen. Permit 431
174-218	Telephone	1	Texaco	-40		3-28	Gen. Permit 431
84-234	Water	20"	Dept. W. & P.	-45	6-1065	10-36	
92-229	Telephone	1	Pacific Tel.&Tel.	-50	5-1674	9-39	
174/175-218	Water	12"	Dept. W. & P.	-40	4606	8-21	
174-218	Power	2	Dept. W. & P.	-40 (bottom)	99344	8-31	Gen. Permit 77-193 (9-478)
84-234	Telephone	1	Pacific Tel.&Tel.	-50	99435 55988	6-33 6-33	Gen. Permit 45-1933
100-150	Oil Line	8"	Standard Oil	-45	5-1214	12-35	
84-234	San. Sewer	2-20"	Dept. Public Works	-55	6-372 6-372-2	4-50	
85-233	Power	1	Dept. W. & P.	-35 (bottom)	5-1765 2-1832	4-40	 Removed G.P. 18-1965
84-234	Fire Alarm	In 20" Sewer	Dept. Bldg. & Safety	-45	6-372	4-50	
174-218	Fire Alarm	In 4" Oil Line	Dept. Bldg. & Safety	-40	7-181	8-56	

Berth Numbers	Utility	Size (Number)	Owner	Depth	Reference Drawing No.	Dwg. Date	Remarks
93A-150	Oil Line	12"	Harbor	-51	1-508		
Badger Ave. Bridge	Gas Line	6-5/8"	So. Cal. Gas		7657 6-781		
171-222	San. Sewer	20"	Dept. Public Works	-52	6-1011	7-65	Gen. Permit 47-1965
174-218	Telephone	1	Pacific Tel.&Tel.	-40			
Badger Ave. Bridge	Water	16"	Dept. W. & P.		88-116		Gen. Permit 12-1952
Badger Ave. Bridge	Power	1	Harbor				
84-233	Telephone	1	Pacific Tel.&Tel.	-50	9-519 6-1163		Gen. Permit 111-1967
94	Power		Dept. W. & P.	-35	2-1832	11-64	Gen. Permit 18-1965 (Abandoning Facilitie
175-216	Oil Line	10"	Mobil	-60	6-1201	9-71	Gen. Permit 156-1971
175-216	Oil Line	24"	Mobil	-60	6-1201	9-71	Gen. Permit 156-1971

FRED E. CRAWFORD
GENERAL MANAGER

MAIL ADDRESS
P. O. Box 151
SAN PEDRO, CALIFORNIA 90733

CABLE ADDRESS
LAPORT

(213) 832-7241
(213) 775-3231

PORT OF LOS ANGELES

CITY OF LOS ANGELES
TOM BRADLEY
MAYOR

October 30, 1978

Colonel Gwynn A. Teague
Corps of Engineers
P. O. Box 2711
Los Angeles, CA 90053

Attention Mr. Dan Muslin

Dear Sir:

SUBJECT: LOS ANGELES HARBOR DEEPENING PROJECT - COST OF REMOVING/ RELOCATING UTILITY LINES FROM PROJECT AREAS

Enclosure: Estimated cost of removing/relocating affected utility lines

INFORMATION:

Transmitted herewith are estimated preliminary costs for removal or relocation of various utilities and pipelines that conflict with the Corps' Dredging Project and associated landfill. These costs were obtained from the respective utility and pipeline owners and are their estimate of costs for execution during the next year. This information was requested by Mr. Dan Muslin, Project Engineer for use in updating the project report.

Very truly yours,

E. L. Gorman

E. L. GORMAN
Chief Harbor Engineer

ABG:dlw
Enclosures

LIST OF ESTIMATED COSTS OR REMOVING/RELOCATING AFFECTED UTILITY LINES

CITY OF LOS ANGELES - DEPARTMENT OF WATER & POWER	
a. 20" water line between Berths 84 and 235	$ 400,000
b. 12" water line between Berths 175 and 218	35,000
CITY OF LOS ANGELES - DEPARTMENT OF PUBLIC WORKS	
a. 20" sewer line between Berths 84 and 235 and a 16" sewer line between Berths 175 and 218	$ 103,000
b. 39" sewer outfall line from Terminal Island Treatment Plant - Extend existing outfall southerly through the proposed south facing retaining dike	1,400,000
CITY OF LOS ANGELES - DEPARTMENT OF PUBLIC UTILITIES & TRANSPORTATION	
a. Communication cable in 20" sewer line between B. 84 & 235	2,000
b. Communication cable and abandoned oil lines between Berths 174 & 218	15,000
CITY OF LOS ANGELES - HARBOR DEPARTMENT	
a. Extend Earle Street strom drain system	330,000
WESTERN UNION	
a. Cable between Berths 100 and 150	70,000
STANDARD OIL COMPANY	
a. 8" oil pipeline between Berths 100-149 & 150	120,000
MOBIL OIL COMPANY	
a. Several oil pipelines between Berths 174 & 218 Remove and construct new lines	2,000,000
PACIFIC TELEPHONE & TELEGRAPH COMPANY	
1 cable between Berths 174 and 218	200,000

ABG:dlw
October 30, 1978

APPENDIX D

TIDAL CIRCULATION TESTS

DEPARTMENT OF THE ARMY
WATERWAYS EXPERIMENT STATION. CORPS OF ENGINEERS
P. O. BOX 631
VICKSBURG. MISSISSIPPI 39180

IN REPLY REFER TO: WESHE 1 March 1979

MEMORANDUM FOR RECORD

SUBJECT: Tidal Circulation Tests of Phase I Modifications for Los Angeles and Long Beach Harbors

PART I: INTRODUCTION

Objectives

1. The purposes of the Los Angeles and Long Beach Harbors model studies are to investigate tidal circulation and basin oscillation characteristics of the existing harbors and to evaluate the impact of proposed harbor modifications upon these phenomena. The specific objective of the tidal circulation study is to determine the effects of proposed modifications on overall tidal circulation and flushing of harbor waters.

2. This memorandum describes the physical model used for testing, discusses model tests of both the existing harbor conditions and the Phase I modification plan, and presents test results showing the effects of this plan on tidal circulation.

Background

3. Los Angeles and Long Beach Harbors are adjacent ports in San Pedro Bay, California. They constitute separate political entities

and are administered by separate port authorities. Modifications to the existing harbors have been proposed by both port authorities and the U. S. Army Corps of Engineers.

4. Harbor modifications proposed by the port authorities consist of phased programs of dredging and landfill construction in the Outer Harbor to permit entry of larger vessels and to provide additional terminal space. The U. S. Army Engineer District, Los Angeles, is studying the feasibility of deepening the present Federal project in Los Angeles Harbor.

5. Proposed modifications are so extensive that a careful examination of their effects on the existing harbor and expanded harbor facilities is required to reduce the possibility of undesirable effects that could prove irreversible or expensive to correct. Of particular interest is the effect of harbor construction on basin oscillations due to long-period waves, currents, and tidal circulation. Basin oscillations and currents can create navigation and berthing hazards and cause mooring problems due to ship motion. Impairment of tidal circulation can prevent proper pollutant assimilation and lead to undesirable water-quality conditions.

6. The phenomena of tidal circulation and basin oscillations can best be studied by using a physical hydraulic model. Therefore, the Congress directed the Corps of Engineers to build a physical model of San Pedro Bay and to conduct studies of the harbors and proposed modifications. Construction of the model at the U. S. Army Engineer Waterways Experiment Station (WES) began in January 1973 and was completed in August of that year.

7. An extensive prototype data collection program was performed to provide data for verification of the model and to describe existing conditions in the harbors. Data on waves and ship movements were collected from May 1971 through June 1972, and tidal data were obtained in June 1972 and March 1974. The prototype data collection program is described in detail in Reference 1, ship motion information is given in Reference 2, an analysis of wave and ship motion is presented in Reference 3, and tidal data are given in Reference 4.

PART II: SAN PEDRO BAY

Description

8. San Pedro Bay is formed by the curvature and indentation of the southern California coastline (Figure 1). Sheltered to the west by Point Fermin, the bay is open to the south and southeast except for the slight protection offered by Catalina Island. Originally an open bay, the protection afforded by its orientation has been augmented by an 8-mile-long breakwater extending from Point Fermin eastward to near Seal Beach.

9. The breakwater consists of three sections. The San Pedro breakwater (oldest of the three) is 11,000 ft long and extends from the shoreline east of Point Fermin to Angel's Gate, which is the navigation opening for Los Angeles Harbor and is 2,100 ft wide. The Middle breakwater is 18,500 ft long and extends from Angel's Gate to Queen's Gate, which is the navigation opening for Long Beach Harbor and is 1,800 ft wide. The Long Beach breakwater is the third section of the breakwater and extends 13,350 ft due east of Queen's Gate.

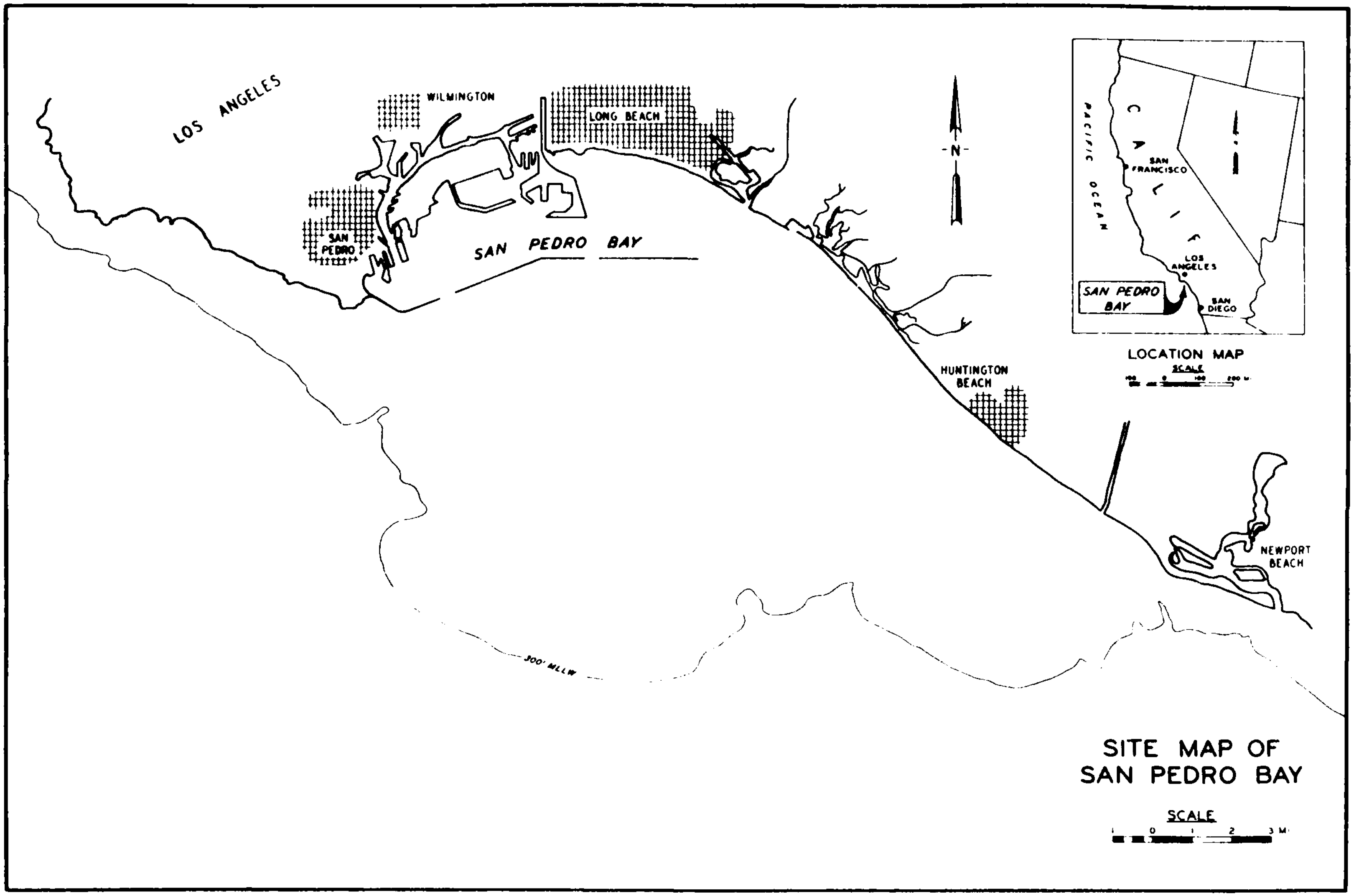


Figure 1. Site map.

10. The San Pedro breakwater is of rubble-mound construction with a cap course of granite blocks to an elevation of 14 ft above mean lower low water (mllw). The Middle and Long Beach breakwaters are of rubble-mound construction, but unlike the San Pedro section have cores (impermeable for all practical purposes) to elevations of -26 and -24 ft mllw, respectively.

11. Tides experienced in San Pedro Bay are of the mixed type (two unequal tides per day). The mean tidal range is 3.8 ft and the mean diurnal (mean higher high to mean lower low) range is 5.4 ft. The maximum astronomical tide range is about 10 ft. Tidal datum is mllw which is 2.8 ft below mean sea level.

12. Despite ample tide ranges, currents in the bay are rather weak with normal maximum current velocities of approximately 1 fps. Wind-induced currents can be of the same order of magnitude as those generated by tides, depending upon wind speed and duration.

13. Freshwater discharges into the harbors are limited to intermittent storm runoff (principally from Dominquez Channel and the Los Angeles River) and a few freshwater effluents. Dominquez Channel, which flows into Consolidated Slip in Los Angeles Harbor (Figure 2) has an average annual flow of 16,000 acre-ft.[5]

14. Lack of significant freshwater inflow results in essentially uniform salinities in the harbors. Salinity of the bay water is very close to that of the surrounding coastal waters, which average about 33 to 34 ppt total salts. Following heavy rains, individual basins may experience storm runoff that results in a low-salinity surface layer; however, these conditions are relatively rare and do not persist.

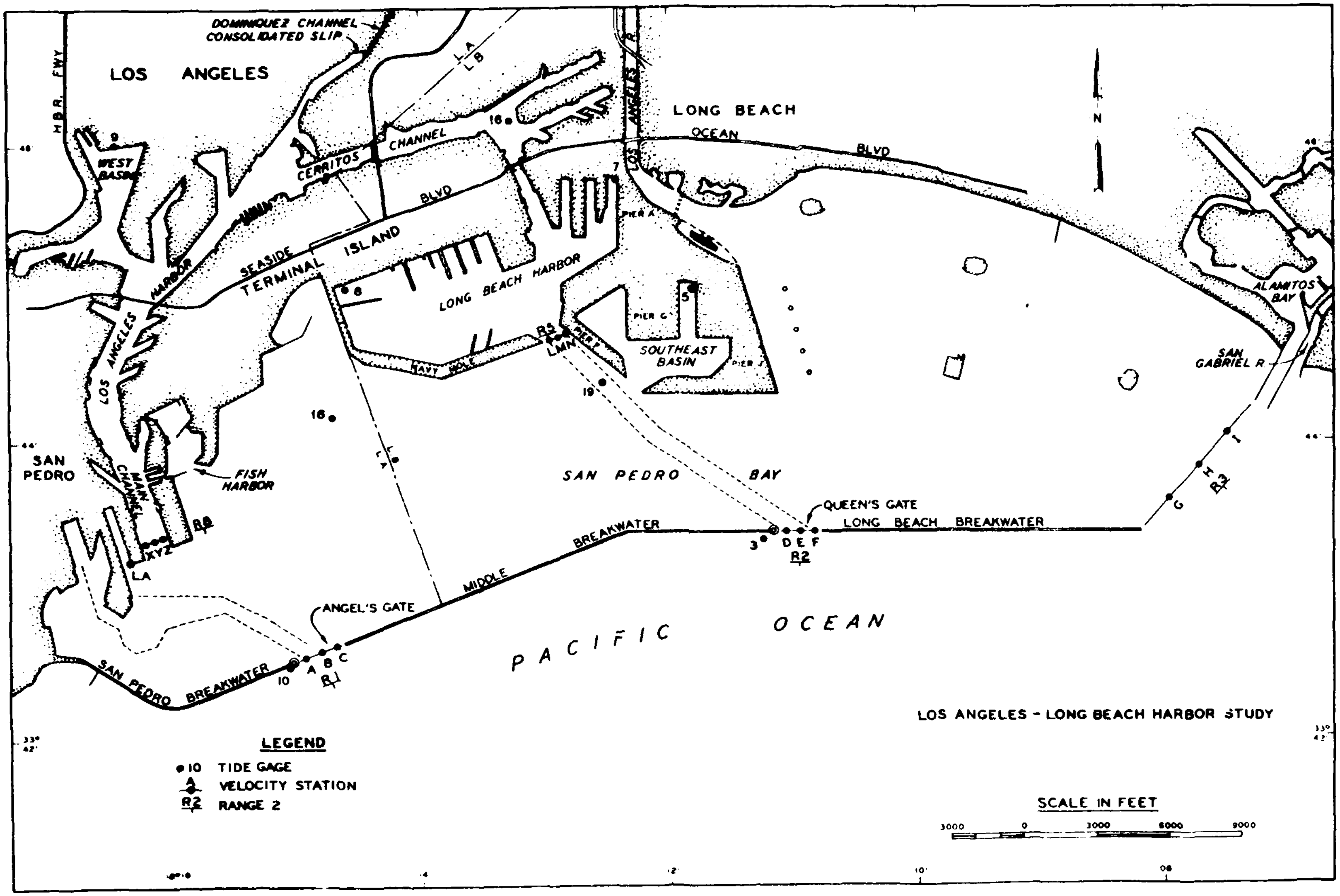


Figure 2. Base conditions and station locations.

15. Low-salinity effluents include cannery wastes in the vicinity of Fish Harbor and treated sewage from the Los Angeles Terminal Island Treatment Plant. Numerous small effluent discharges occur in the harbors, but their effect upon gross circulation patterns is not significant.

16. Thermal stratification is encountered in San Pedro Bay, ranging from mild seasonal temperature gradients to strong gradients due to cooling water discharges. Ambient surface temperatures have an average of about 55°F in winter and 68°F in summer.[6]

17. The principal cooling water discharges in Los Angeles Harbor are in West Basin. The Union Oil refinery cooling water discharge averages about 26 mgd and has a maximum flow of about 30 mgd.[7] The city of Los Angeles' Harbor Steam Plant also is located adjacent to West Basin. It withdraws water from Los Angeles Harbor slip 5 and discharges it into the northeast corner of West Basin at an average rate of 78 mgd.[6] It has a capacity flow of 397 mgd with a temperature rise of 12 to 15°F.[8] The plant operates at intervals dictated by peak electrical demand.

PART III: THE PHYSICAL MODEL

Description

18. The physical hydraulic model reproduces San Pedro Bay and a portion of the Pacific Ocean surrounding it (see Figure 3). The model limits encompass the coastline from approximately 2 miles northwest of Point Fermin southeastward to Huntington Beach. The offshore bathymetry is reproduced out to the -300 ft contour, but the model extends beyond

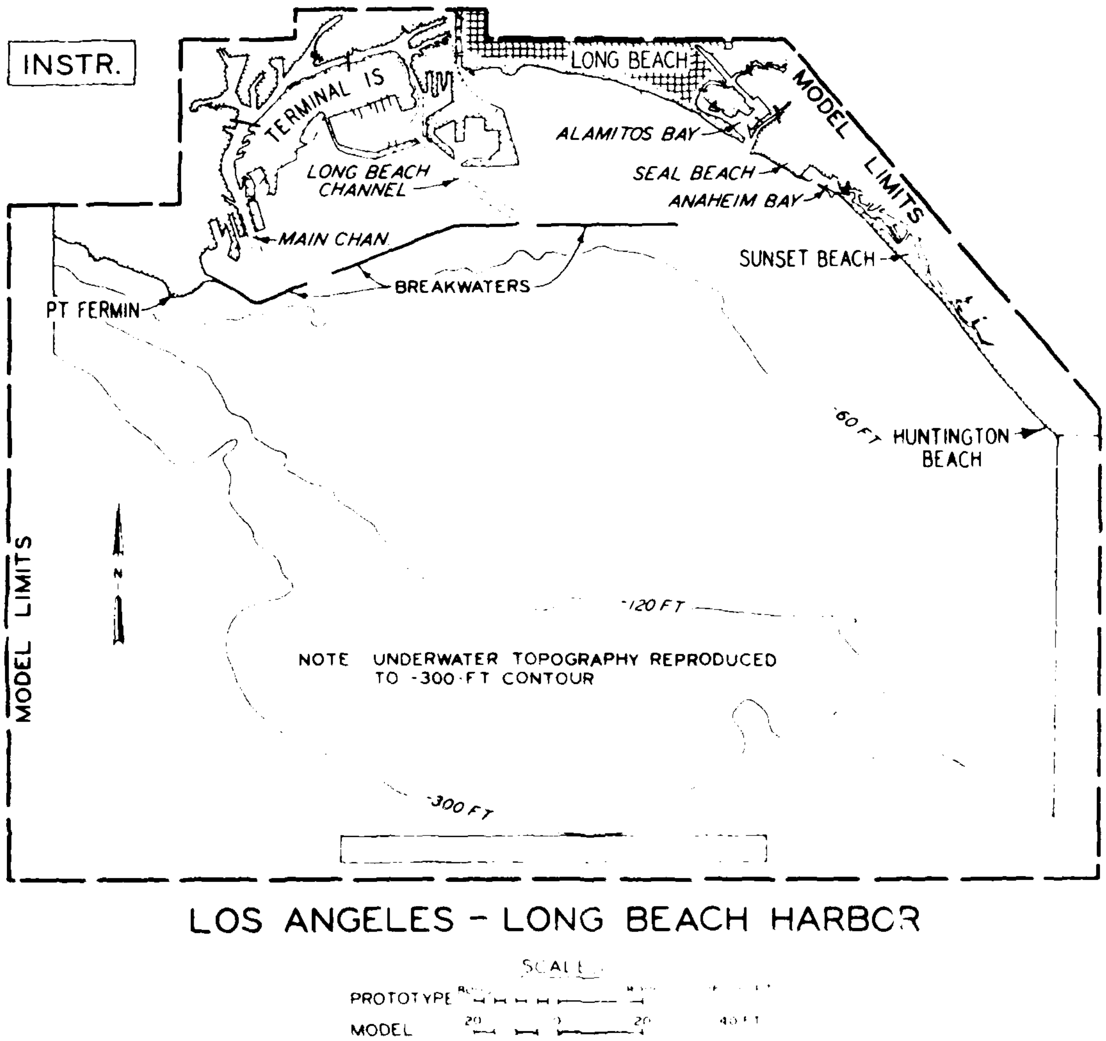


Figure 3. Model limits.

the -300 ft contour to provide room for wave and tide generators. The 44,000 sq ft of the model represent about 253 square miles of prototype area.

19. The downcoast embayments such as Alamitos Bay and Anaheim Bay are correctly reproduced in plan, but water depths within the bays were approximated to expedite construction. This permitted proper reproduction of approximate tidal volumes in the embayments so that their gross effects upon the system are included; however, it does not permit detailed studies within these bays unless they are reconstructed to the precise existing bathymetry. Should such studies be desired, it would be a relatively easy modification to perform.

20. The model was constructed of concrete to linear scales of 1:100 vertically and 1:400 horizontally, which resulted in the following model-to-prototype scales, based on the Froudian relations, for the harbor circulation and tidal flushing tests:

Vertical length	1:100
Horizontal length	1:400
Surface area	1:160,000
Velocity	1:10
Time	1:40

21. The model breakwaters were designed to correctly reproduce the wave transmission and reflection characteristics of the prototype breakwater. Two-dimensional wave flume tests were conducted to determine the proper model breakwater rock size scale for the basin oscillation study (model wave periods = 0.5 to 10 sec), which was found to be approximately the same as the vertical length scale of 1:100. The impermeable

core of the breakwater was reproduced in the model; however, in the tidal circulation tests, it was necessary to seal the breakwater with an additional amount of plastic sheeting (up to the -26 ft mllw level) to simulate the correct transmission for the tidal periods.

22. Major piers, wharves, and quays within the harbors were built in the model to reproduce their effects upon the flow. Piles are simulated by 1/16- and 1/32-in.-diam brass rods.

23. The model was operated completely with fresh water since the relatively homogeneous salinity of the bay waters does not lead to significant ambient density stratification.

24. The model has been verified to satisfactorily reproduce astronomical tidal elevations at 13 locations, tidal currents at 5 ranges, and overall circulation in the outer harbors for existing conditions and a spring range tide.[4,9] Phenomena not modeled in the circulation tests include wind waves, longshore currents, oceanic currents, wind-induced currents, wind-induced setup, barometric water-surface elevation changes, and stratification caused by natural temperature changes or natural salinity variations. It is estimated that all these phenomena are relatively unimportant to the overall mean circulation in the harbors complex. Wind-induced surface currents can and probably do sometimes make substantial alteration in the surface currents; however, their effect on the volume transports and gross harbor circulation and flushing is probably relatively small. Thus it is felt that model results satisfactorily depict relative alterations to the overall circulation and flushing of the harbors.

OPERATION OF THE TIDE GENERATOR SYSTEM

The water surface in the model (A) is higher than in the sump (B). A pump (C) discharges a constant flow of water into one side of the chambered headbay (D). Gravity discharge from the model back to the sump is controlled by an automatic, roll-gate valve (E). If the valve is opened so that more water leaves the model than is being pumped in, the water-surface elevation in the model is lowered. If the valve is partially closed so that less water leaves than is being pumped in, the water surface rises.

The desired tide is programmed by a radially eccentric cam (F). The mechanical signal generated by the cam is converted to an electrical signal by the positioner amplifier (G) and transmitted to the bubble tube positioner (H). The bubble tube positioner moves an air bubbler tube in the same direction that the water surface should go to produce the desired tide. The air pressure sensed by the bubble tube serves as input to one side of a hydraulic controller (I). The pressure difference (error in water-surface elevation) between the bubble tube pressure and a preset controller pressure is amplified 50,000 times by the controller and is used to move the automatic gate valve (E) as necessary to obtain the correct water-surface elevation. An electronic feedback from the automatic gate valve through the positioner amplifier (G) moves the bubble tube positioner in the same direction as the valve, thus minimizing undesirable system oscillations.

The following describes the sequence of operations that would occur in the simple case of the tide controller raising the water-surface elevation from a steady-state condition:

1. The program cam (F) indicates that the water surface is to rise 1 in. A potentiometer converts this mechanical signal to a voltage and transmits it to the positioner amplifier (G).
2. The positioner amplifier amplifies the signal and transmits it to the bubble tube positioner (H), which rises 1 in.
3. The air pressure in the bubble tube is reduced by its decreased submergence.
4. The differential between the bubble tube pressure and a preset pressure is converted to hydraulic pressure and amplified by the hydraulic controller (I).
5. The amplified hydraulic pressure differential activates a hydraulic pressure cylinder atop the automatic gate valve (E), causing it to close slightly.
6. The downward movement of the gate valve is converted to an electrical signal by another potentiometer, and the signal is transmitted back to the positioner amplifier (G).
7. The positioner amplifier causes the bubble tube positioner to move down a small amount and thus slows down the rate of gate valve closure.
8. The system continues to respond to the changing water-surface elevation until the desired 1-in. rise is accomplished.

Figure 5. Operation of tide generation system.

29. Photographic lighting consisted of thirty-four 1000-watt lamps. At the end of each exposure period, an electronic flash strobe light was fired to produce a white dot on the leading end of each confetti streak.

Accuracy of Model Measurements

Tidal elevations

30. The point gages used to read tidal elevations in the model have a vernier scale graduated in 0.001 ft (0.1 ft prototype) and interpolation permits readings to the nearest 0.0005 ft (0.05 ft prototype). Most important to tidal elevation measurement accuracy are timing of the readings and zeroing the gages. A synchronized light system indicates when readings are to be taken. For the tide used in the verification tests, a delay of 5 sec after the light in measuring tidal elevation can result in a maximum error of about 0.0008 ft. The timing of the readings can be grouped with other minor sources of error arising from the characteristics of the person making the measurement, resulting in an accuracy of about ±0.001 ft. Error in gage zeroing can be expected to be less than 0.0005 ft, so the combined accuracy may be considered to be ±0.0015 ft (0.15 ft prototype).

Current velocities

31. Possible sources of error in the measurement of current speed include:

a. Travel time errors
   (1) Clock inaccuracy
   (2) Delay in starting and stopping clock due to individual reaction time
   (3) Rounding readings to nearest 0.1 sec

b. Travel distance errors

(1) Deformation of the annular rings from their nominal spacing

(2) Parallax effect in observing the float's transit of the annular rings

(3) Curvilinear path of the float

c. Float device errors

(1) Vertical velocity gradient acting on the float stem

(2) Averaging speed over time and distance

(3) Assignment of the observed current speed to the beginning time of the measurement

32. Travel time errors have a relatively constant maximum total value of about 0.6 sec; therefore, their effect is most pronounced at higher speeds. At 0.5 fps, the error is about ±0.03 fps; and at 1.0 fps, it is about ±0.1 fps. Travel distance errors vary according to current speed with the greatest distance error, that of a curvilinear float path between the annular rings, occurring at low speeds (<0.5 fps). The distance error at speeds of less than 0.5 fps results in a velocity 19 percent too high, or a maximum error of +0.1 fps. For current speeds greater than 0.5 fps, travel distance errors result in velocity errors of ±5 percent (0.05 fps at 1 fps).

33. The effect of a vertical velocity gradient on the float velocity when measuring bottom current speeds has been investigated analytically and experimentally. The effect may be compensated by use of a correction factor that accounts for current speeds at depths shallower than the measurement depth. The correction factor has not been applied to data in this report since the maximum difference

between surface and bottom current speeds is of the order of magnitude of the data accuracy. Using a 6-in. travel distance on either side of a 3-in. center ring results in a velocity reading that is averaged not only with respect to time but also spatially. The averaging distance is 250 ft (prototype) to either side of the measuring station. Averaging the current speed over this distance is not a significant problem when comparing two sets of model data but can cause discrepancies between model and prototype data. No general error magnitude can be assigned to this effect, but it should be borne in mind when making model-to-prototype data comparisons.

34. Averaging current measurements over time creates a problem in plotting the data. Since each measurement begins at a specified time and is plotted at that beginning time, the plots tend to be distorted somewhat, with low current speeds affected more than high speeds. At the minimum speed recorded, 0.1 fps, the values are plotted 33 min (prototype) earlier than the center point of the reading.

35. When all three error types are considered, the model current speed measurements should be considered accurate to ± 0.2 fps (prototype).

Surface currents

36. Errors occurring in scaling current speeds on surface current photographs are principally due to photographic distortion. The wide angle lens used introduces distortion near the edge of the photographs and further distortion may be introduced either by a camera that is not level or in photographic processing. Other potential error sources include slight elevation differences between cameras which results in different length scales, and deviation of film exposure time from the nominal duration.

37. Most of these errors are minimized by ordinary care in the photographic process. Each camera is carefully mounted on a rigid catwalk to maintain the same elevation as adjacent cameras and each is leveled separately. Reproduction work is performed under exacting standards designed to reduce photographic error. Distortion caused by the wide angle lens is offset by providing 15 to 20 percent overlap between adjacent photographs. Since the information obtained from the surface current photographs is general current patterns and approximate current speeds, error remaining after exercising reasonable care is not a major concern.

38. Under unsteady tidal flow conditions, transitory, nonperiodic disturbances in the flow field will occur. If these disturbances are large enough they pose a problem in analyzing mosaics consisting of nonsimultaneous photographs. In these tests, in which five camera setups are used over several days to obtain complete harbor coverage, transitory disturbances are a potential problem. Adjacent photographs taken on different days may show differing current directions or magnitudes where the photographs overlap. Noting the occurrence of these inconsistencies is useful in identifying unstable flow conditions. The chief protection against being deceived by transitory disturbances is an awareness of their existence.

PART IV: PHASE I (MODIFIED) PLAN TESTS

39. The modified (June 1978) Phase I harbor configuration is shown in Figure 6. Modifications for this Phase I plan consist of a 45-ft-deep channel in the Los Angeles Harbor Main Channel, a landfill east of Fish Harbor, a 65-ft-deep channel dredged to Pier J from Queen's Gate, and a breakwater and piers adjacent to Pier J in Long Beach Harbor.

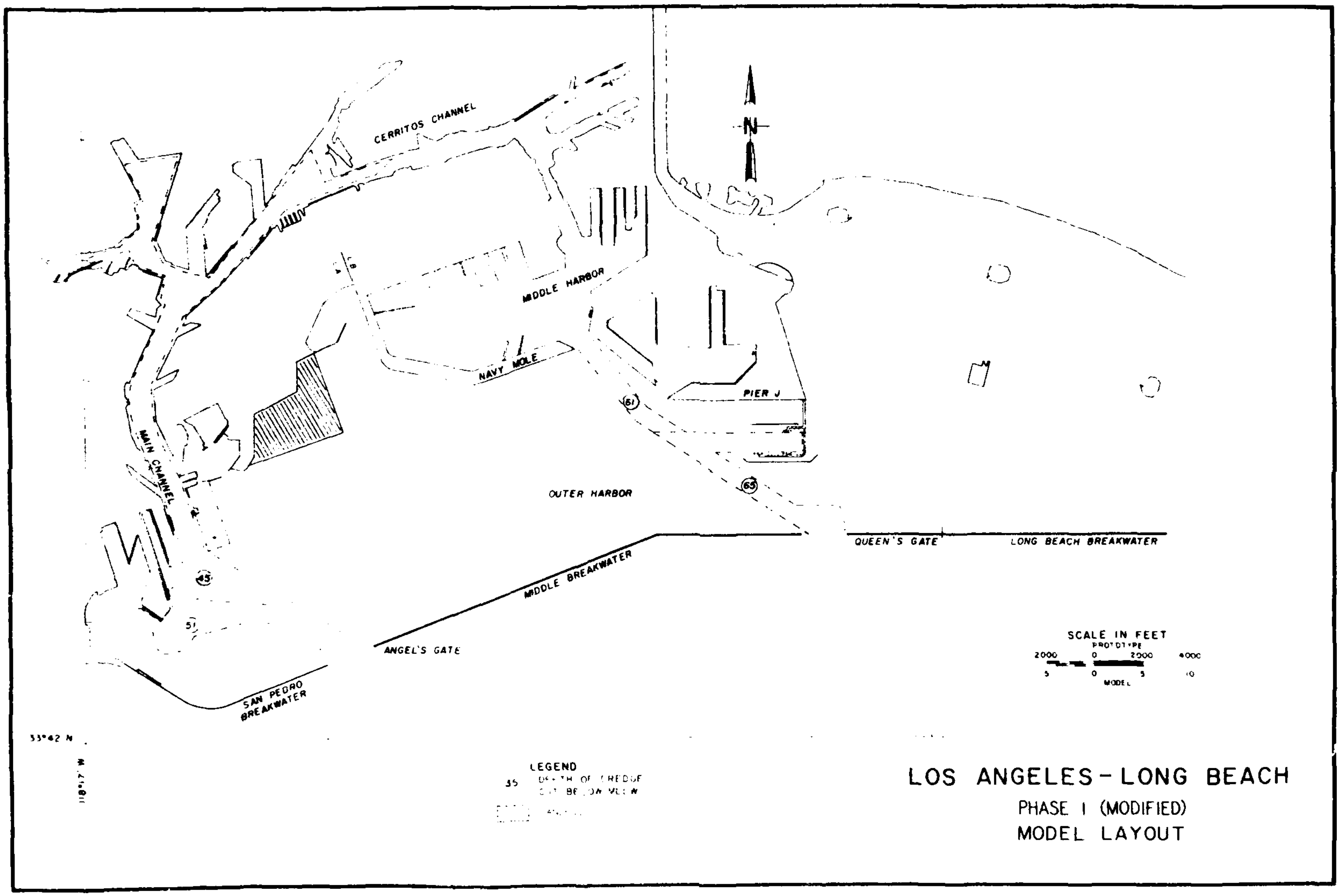


Figure 6. Phase I (Modified) model layout.

Tests Description

40. After model verification, base tests of the configuration of the existing harbors were conducted. Base tests define existing conditions--those with which test results of proposed modifications can be compared. Differences in base and plan test results under controlled laboratory conditions can be directly attributed to the plan being tested. In addition, minor discrepancies between model and prototype hydrodynamic response are filtered out by comparison of model plan results with model base results.

41. The tidal condition used in the model tests was a typical spring tide with a 7.1-ft diurnal range. Test measurements consisted of tidal elevations at 10 stations and current velocities at 5 ranges (Figure 2). Surface current patterns were recorded by time-exposure photographs.

42. Surface current photographs were made by 10-sec exposures (400 sec prototype) of confetti floating on the water surface. Motion of the confetti during the exposure period results in photographs of streaks whose lengths are proportional to the current speed. Current speed may be scaled directly on the photographs after the width of the confetti chip is subtracted. Near the end of the exposure period, a strobe flashes and causes a dot to appear in the photographs toward the leading end of each streak, which shows the direction of flow. Photographs were taken on the prototype hour for a complete tidal cycle at each of 42 camera positions in the base tests and 52 positions in the plan tests. Only 9 to 12 cameras (a change in camera types resulted in an increased number of positions) could be operated at once, so five setups were necessary to cover the entire area of interest. After the surface current photographs were printed, they were assembled into mosaics of the entire harbor.

Flow Rates Computation Method

43. The discharge through each velocity range was computed over a tidal cycle for both the base and Phase I plan so that net flows could be compared. For the discharge calculations, the cross-sectional area of each range was divided into eight or nine subareas corresponding to the velocity reading locations; and instantaneous elemental discharges were computed by multiplying current speeds by their respective subareas. (In an open system such as Los Angeles-Long Beach Harbors, the tidal currents seldom go completely slack; instead, the current direction begins to rotate as slack water approaches. In the tests, model current speeds of less than 0.1 fps but greater than 0.0 were recorded as 0.05 fps.) Discharge data obtained by this technique have been termed "apparent discharges" because the method assumes the velocity vector to be normal to the cross-sectional area. Direction has been included only in identifying a flow as ebb or flood. The comparison between base and plan apparent discharges should be good even if the flows are not normal to the range, provided the directions of flow are the same.

44. Net flow volumes across each velocity range were computed by numerically integrating the discharge versus time data curve. For these tests the integration technique was revised from that used for base test results given in reference 4, and in order to insure consistency between the results, net flows for the base test were recomputed. The new computation scheme used the trapezoidal rule on hourly discharge values; whereas, previously, integration was performed by planimeter using a half-hour data interval. The revised technique produced values of net flow that differed in magnitude, but not in direction, from those previously presented.

45. The net flow volumes shown here should be used with caution because there is an opportunity for large errors in these numbers. The net volumes are small in comparison to the gross ebb and flood volumes and errors of a small percentage of the gross volumes may be large compared to the net flow. Small errors in current speed and direction can also result in large errors in net flow volumes.

PART V: TEST RESULTS

Spring Tide Tests

Tides

46. Plates 1-4 show spring range tidal elevations for the base and plan tests. It can be seen that the plan had no significant effects on tidal elevations at any of the stations.

Current velocities

47. Spring tide current velocities for base and plan tests are plotted in Plates 5-19. Current speeds at Station 1A were approximately equal in the plan and base tests, but were out of phase about 30 min. At Station 1B the ebb velocities at middepth and bottom were slightly greater in the plan test than in the base test. Also, the second flood started sooner and had a longer duration. At Station 1C the entire velocity curve showed a shift in the ebb direction for both flood and ebb phases.

48. Plan test velocities at Station 2E were about equal to the base test velocities during flood conditions, but slightly greater than the base test velocities under ebb conditions. At 2F both flood and ebb velocities were smaller in the plan test than in the base test. Velocities at Station 2D showed no consistent differences between base and plan.

49. Current speeds at Station 3G showed greater flood velocities in the plan test than in the base, while ebb velocities were slightly smaller. The first flood was longer in the plan test and the first ebb (starting at about hour 8) was shorter. Both ebb and flood velocities were slightly reduced at Station 3H, but there was a definite shift of the entire curve toward the flood direction. As a result, the duration of flood flow was increased and the ebb duration was reduced. Station 3I also showed a slight shift toward flood, with the second ebb (starting at about hour 24) approaching slack water.

50. At Station 5L the plan test flood velocities were approximately the same as the base test, but the ebb velocities were slightly less. At Station 5M both ebb and flood velocities at the surface and middepth were reduced slightly in the plan test. Station 5N showed a reduction in both flood and ebb velocities in the plan test.

51. Range 8 current velocities exhibited some differences from the base test, but they were mostly minor. At Station 8X peak flood velocities at the bottom were somewhat reduced in the plan test, while at 8Y both flood and ebb peaks were slightly lower than in the base test. At Station 8Z differences in phasing can be observed but peak speeds were unchanged.

Net flows

52. Net apparent discharges were computed for the base and plan spring tidal range tests as described in paragraph 44 and results of these computations are shown in Table 1. The numerical values of net flow should be used only as an indication of the direction and approximate magnitude of net flow. Range 5 flows are not included because verification tests showed them to be unreliable figures.

TABLE 1

Apparent Net Tidal Discharge
Per Tidal Cycle, Spring Tide

Range	Base 10^6 cu ft	Phase I Modified 10^6 cu ft
1	900	210
2	170	5
3	-1700	-44
8	-34	-19

Note: Negative values indicate net ebb flows.

53. For a spring tide Range 1 showed a net flood flow for both base and plan test conditions, but the magnitude was substantially reduced (from 900 x 10^6 to 210 x 10^6 cu ft). At Range 2 net flow was reduced from a fairly strong net flood to a nearly balanced flow. The computed value of 5 x 10^6 cu ft for Range 2 is so small with respect to the total tidal flow that a net flow direction cannot be determined by these techniques. Range 3 also experienced a substantial reduction in net flow from -1700 x 10^6 to -44 x 10^6 cu ft, but the direction was ebb in both base and plan.

54. Calculated net flows at Range 8 were -34 x 10^6 cu ft for the base and -19 x 10^6 cu ft for the plan test. This shows a net westward flow in Cerrittos Channel for both base and plan. The amount of net flow reduction may not be significant with respect to accuracy of the calculations.

Circulation patterns

55. Plates 20-23 illustrate surface current patterns for the spring tide at the strength of ebb and flood flows. Plates 20 and 22 show base condition current patterns for maximum flood and maximum

ebb conditions, respectively, and Plates 21 and 23 show Phase I condition current patterns for maximum flood and ebb, respectively.

56. At hour 6 of the tidal cycle, which is approximately the time of maximum flood flow, the Phase I condition (Plate 21) resulted in some differences in circulation from the base condition (Plate 20). Notable features of circulation for Phase I include:

a. The large clockwise gyre in the Outer Harbor that was such a dominant feature of the base condition still existed in Phase I, but was not as well defined as before.

b. The smaller, counterclockwise gyre that supplied flood flow to Los Angeles Main Channel appeared to be essentially the same in base and plan tests.

c. Flow through Queen's Gate divided around the proposed oil terminal breakwater, with a substantial portion of the flow turning westward. The counterclockwise gyre just west of Queen's Gate was essentially eliminated.

d. Current patterns in the eastern portion of the bay were essentially similar in base and plan, except that the gyre east of Pier J was quite a bit weaker under Phase I conditions.

e. The inflow east of Long Beach Breakwater was somewhat stronger for Phase I than for the base test.

57. Current patterns at hour 13, the strength of ebb flow, are shown in Plates 22 and 23 for the spring range tide. Notable features include:

a. For Phase I, the large gyre in the Outer Harbor was better defined than at hour 6, but was not as strong as in the base test and covered a much smaller area.

b. Ebb flow from the Los Angeles Main Channel did not turn east until nearing the breakwater, just as in the base test.

c. Ebb flow through Queen's Gate tended to come primarily from the east, rather than the west as observed in the base test.

d. Outflow east of Long Beach Breakwater was somewhat weaker for Phase I than for the base test.

58. The above observations reinforce net flow directions for Ranges 1-3 shown in Table 1. The plan appears to have brought ebb and flood volumes at each of the breakwater openings more nearly into balance, diminishing net westward flow in the Outer Harbor. This is also reflected in the velocity plots for Ranges 1 and 2, where a shift toward stronger ebb velocities was noted (paragraphs 47 and 48).

Conclusions

59. The Phase I (modified) plan did not significantly affect tidal elevations or phases at any of the tidal data stations.

60. Current velocities were affected by the plan to a small but noticeable degree. Stations on Ranges 1 and 2 experienced a small shift toward larger ebb velocities and smaller flood velocities; whereas, at Range 3 the reverse occurred. The plan introduced only minor changes at Ranges 5 and 8.

WESHE 1 March 1979
SUBJECT: Tidal Circulation Tests of Phase I Modifications for Los Angeles and Long Beach Harbors

61. Direction of net flow did not reverse at any of the four ranges for which computations were performed; although the net flood flow at Range 2 was reduced to such a small magnitude that the direction of net flow is uncertain. Magnitudes of net flow in the plan test were reduced from base test results at Ranges 1, 2, and 3 as the gross ebb and flood volumes came more nearly into balance. This suggests that the net easterly flow observed in the outer harbors under base conditions[4] had been reduced by the plan. Net flow in Cerrittos Channel was westward toward Los Angeles Harbor in both base and plan tests. Magnitude of that net flow at Range 3 did not change significantly.

62. The plan test surface current patterns demonstrated some differences from base tests. Primary changes were that the large clockwise gyre in the outer harbor was less well defined in the plan test, flood flows through Queen's Gate were altered somewhat by the proposed Pier J oil terminal, and the imbalance between ebb and flood flows across the western entrance to the bay (Range 3) was reduced.

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Engineer
Harbor Entrance Branch

J. Phillip Stewart
J. PHILLIP STEWART
Engineer
Harbor Entrance Branch

24 Incl
1. References
2-24. Plates

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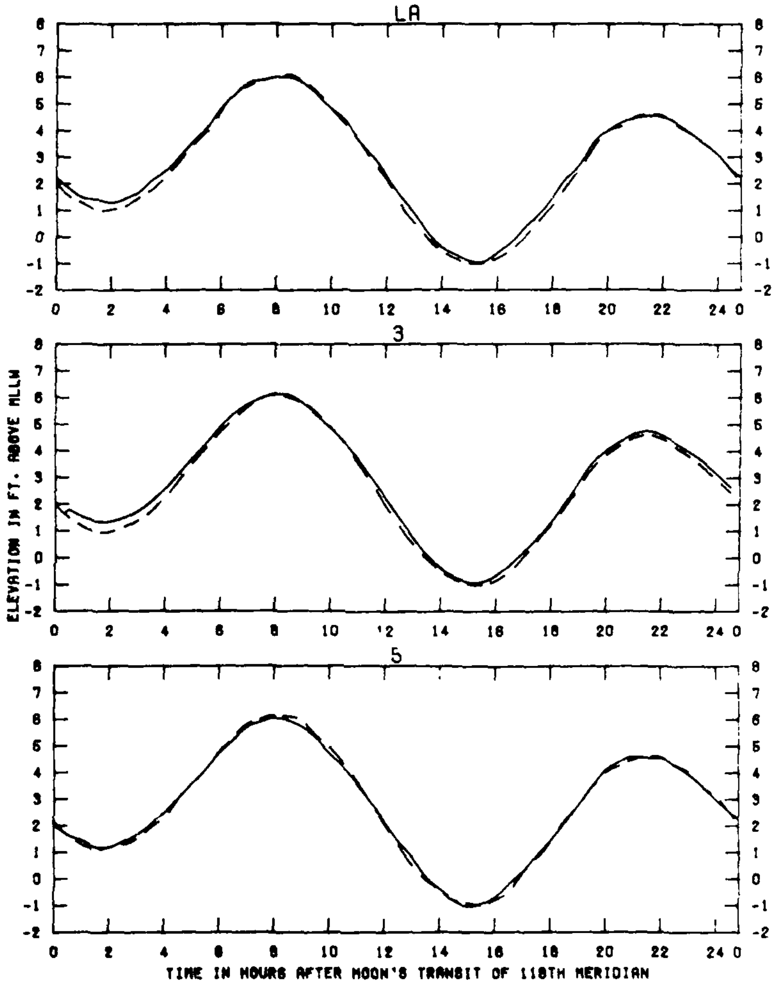
9. McAnally, W. H., "Physical Model of San Pedro Bay Tidal Circulation," PORTS 77, 1977, American Society of Civil Engineers, New York, NY.

Incl 1



TEST CONDITIONS
TIDAL RANGE AT QUEEN'S GATE = 7.1 FT

LOS ANGELES - LONG BEACH MODEL
TIDAL CIRCULATION STUDY

TIDAL ELEVATIONS
PHASE 1 MODIFIED
SPRING TIDE

STATIONS
LA, 3, AND 5

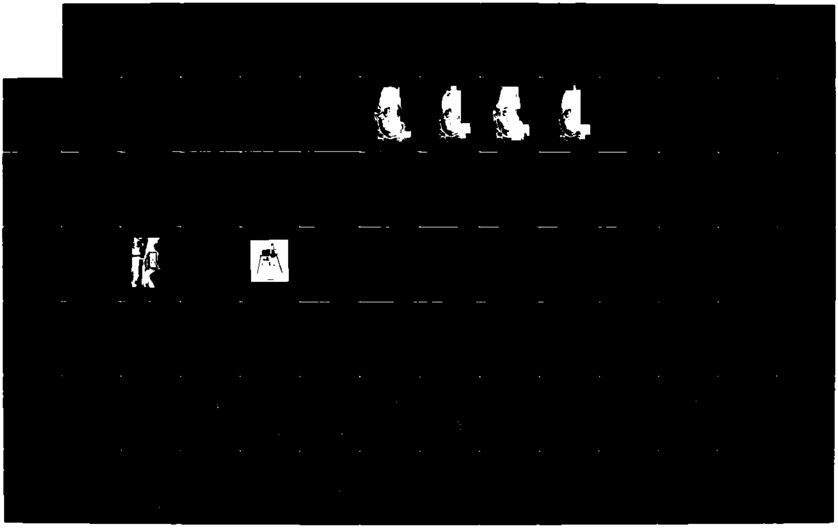
LEGEND
BASE ———
PLAN P1 — — —

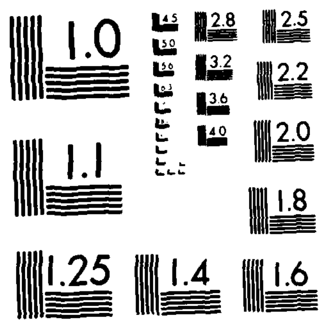
Plate 1

Incl 2

AD-A171 216 LOS ANGELES - LONG BEACH HARBORS CALIFORNIA LOS ANGELES HARBOR DEEPENING..(U) ARMY ENGINEER DISTRICT LOS ANGELES CA JAN 80 4/6

UNCLASSIFIED F/G 13/2 NL

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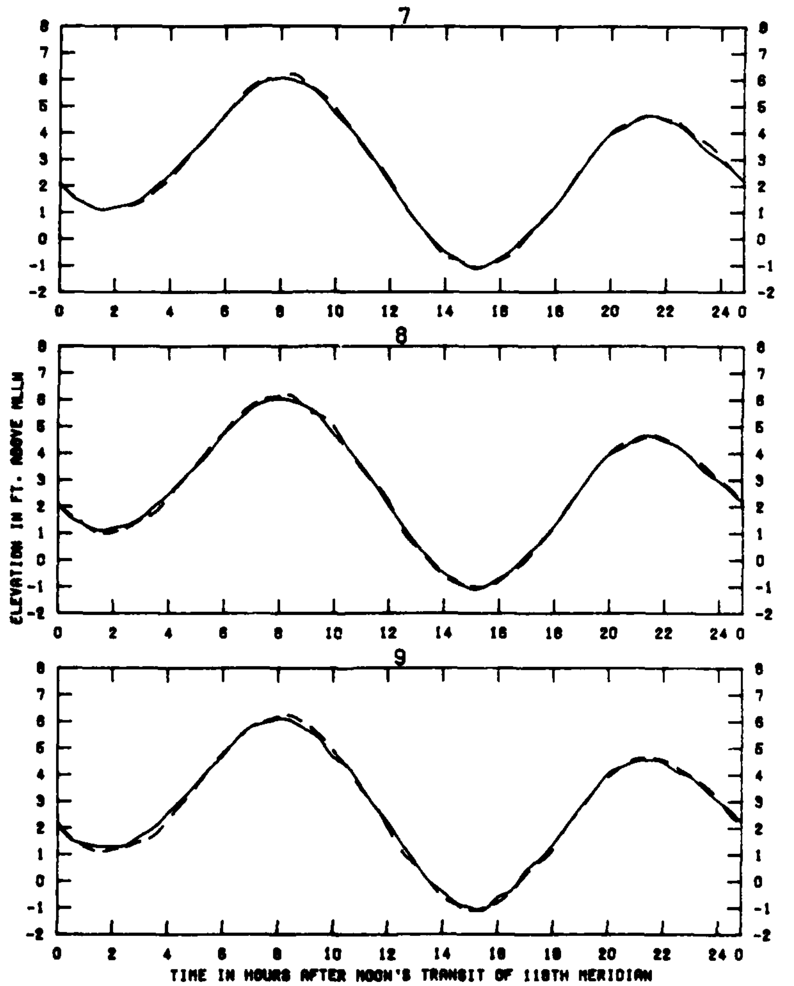
1.6



TEST CONDITIONS
TIDAL RANGE AT QUEEN'S GATE = 7.1 FT

LEGEND
BASE ———
PLAN P1 - - -

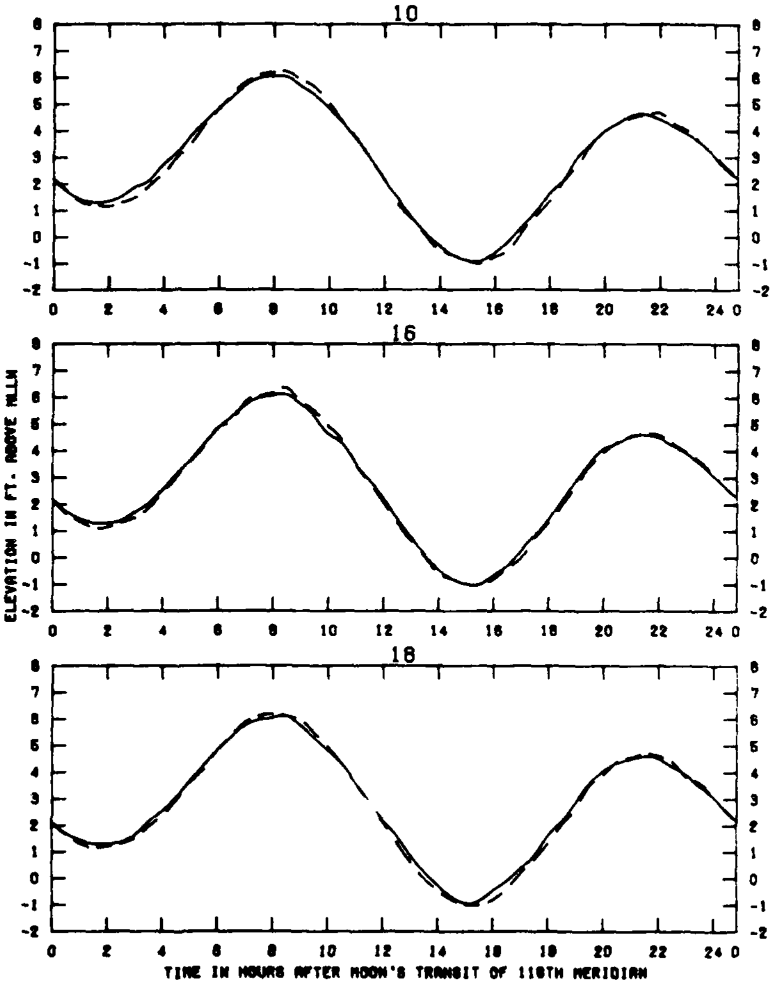
LOS ANGELES - LONG BEACH MODEL
TIDAL CIRCULATION STUDY

TIDAL ELEVATIONS
PHASE 1 MODIFIED
SPRING TIDE

STATIONS
7 , 8 , AND 9

Plate 2

Inal 3



TEST CONDITIONS
TIDAL RANGE AT QUEEN'S GATE = 7.1 FT

LOS ANGELES - LONG BEACH MODEL
TIDAL CIRCULATION STUDY

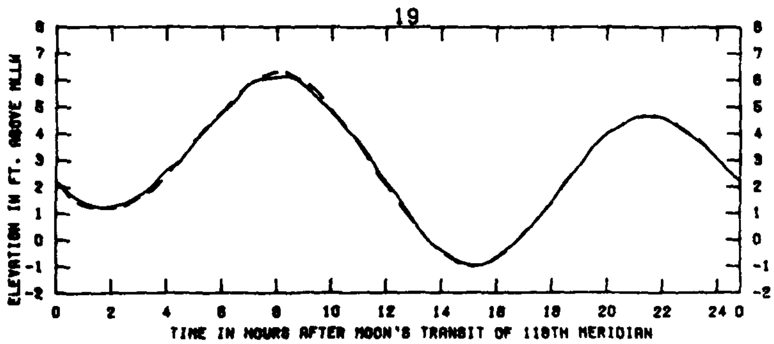
TIDAL ELEVATIONS
PHASE 1 MODIFIED
SPRING TIDE

STATIONS
10, 16, AND 18

LEGEND
BASE ——
PLAN P1 — — —

Plate 3

Incl 4

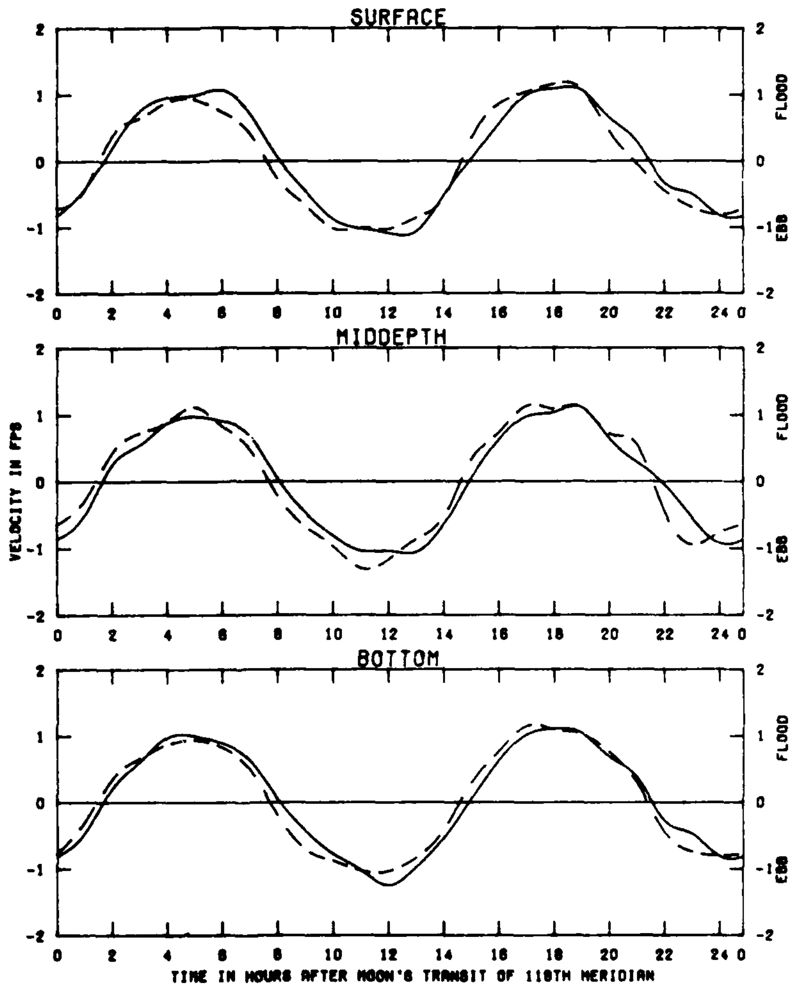


TEST CONDITIONS
TIDAL RANGE AT QUEEN'S GATE = 7.1 FT

LEGEND
BASE ————
PLAN P1 — — —

LOS ANGELES - LONG BEACH MODEL
TIDAL CIRCULATION STUDY
TIDAL ELEVATIONS
PHASE I MODIFIED
SPRING TIDE
STATION
19

Incl 5



TEST CONDITIONS
TIDAL RANGE AT QUEEN'S GATE = 7.1 FT

LOS ANGELES - LONG BEACH MODEL
TIDAL CIRCULATION STUDY

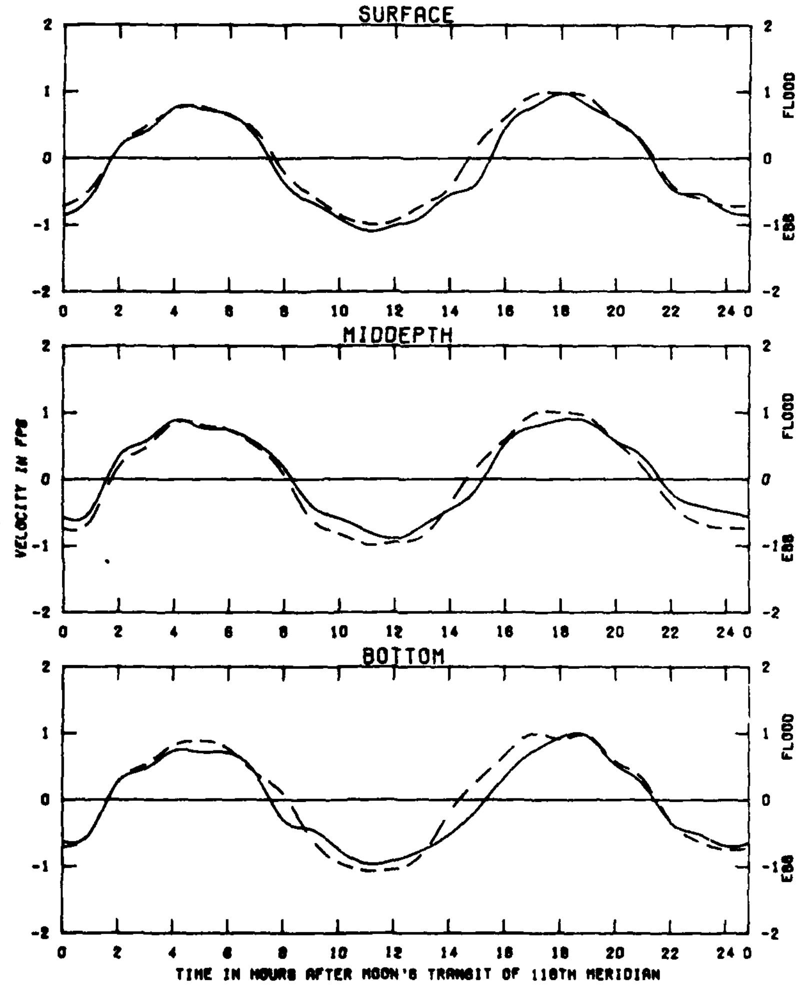
VELOCITIES
PHASE 1 (MODIFIED)
SPRING TIDE

STATION
1A

LEGEND
BASE ———
PLAN P1 – – –

Plate 5

Incl 6



TEST CONDITIONS
TIDAL RANGE AT QUEEN'S GATE = 7.1 FT

LOS ANGELES - LONG BEACH MODEL
TIDAL CIRCULATION STUDY

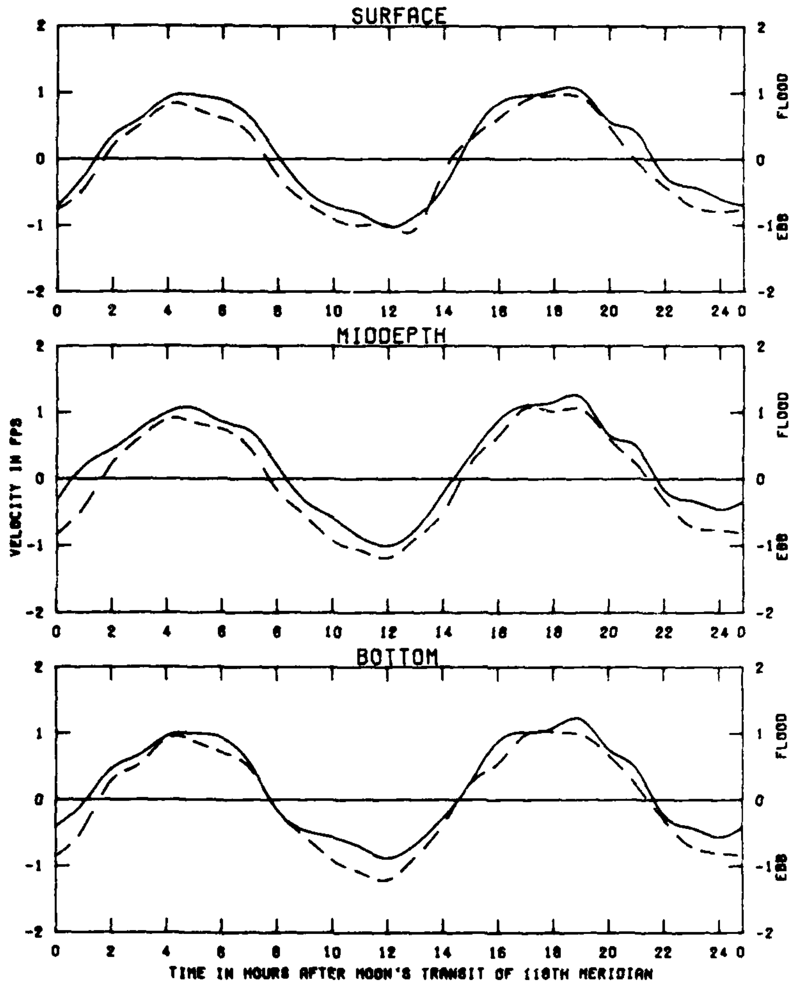
VELOCITIES
PHASE 1 (MODIFIED)
SPRING TIDE

STATION
18

LEGEND
BASE ———
PLAN P1 – – –

Plate 6

Incl 7



TEST CONDITIONS
TIDAL RANGE AT QUEEN'S GATE = 7.1 FT

LOS ANGELES - LONG BEACH MODEL
TIDAL CIRCULATION STUDY

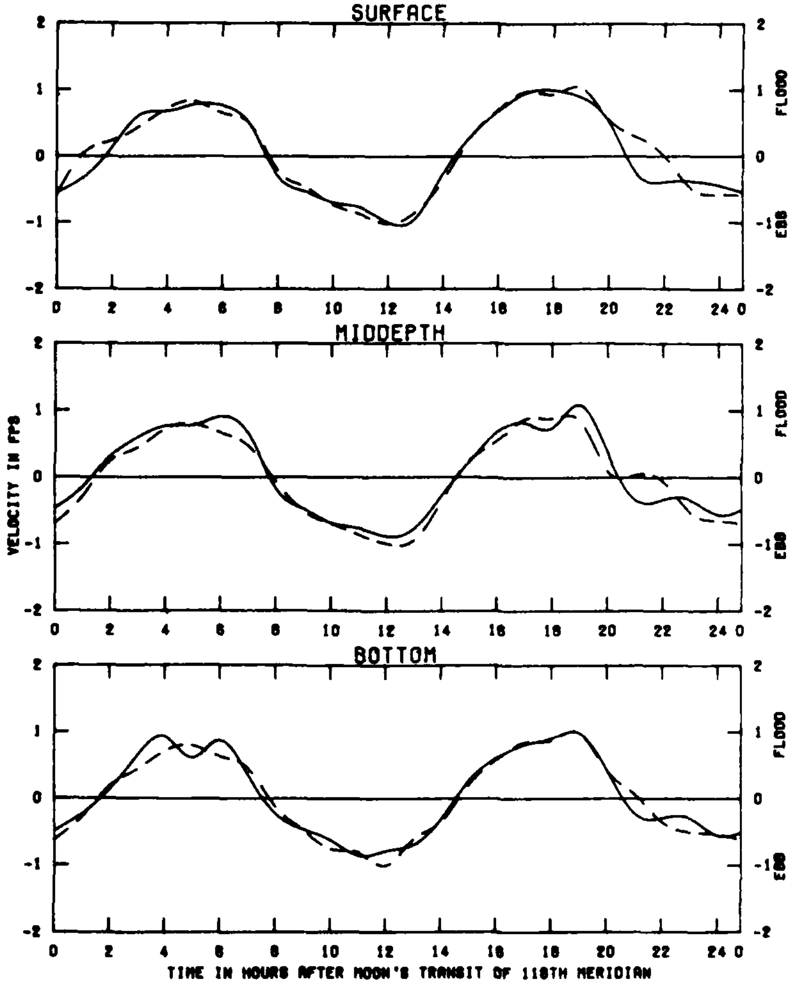
VELOCITIES
PHASE 1 (MODIFIED)
SPRING TIDE

STATION
1C

LEGEND
BASE ———
PLAN P1 – – –

Plate 7

Incl 8



TEST CONDITIONS
TIDAL RANGE AT QUEEN'S GATE = 7.1 FT

LOS ANGELES - LONG BEACH MODEL
TIDAL CIRCULATION STUDY

VELOCITIES
PHASE 1 (MODIFIED)
SPRING TIDE

STATION
20

LEGEND
BASE ———
PLAN P1 - - -

Plate 8

Incl 9

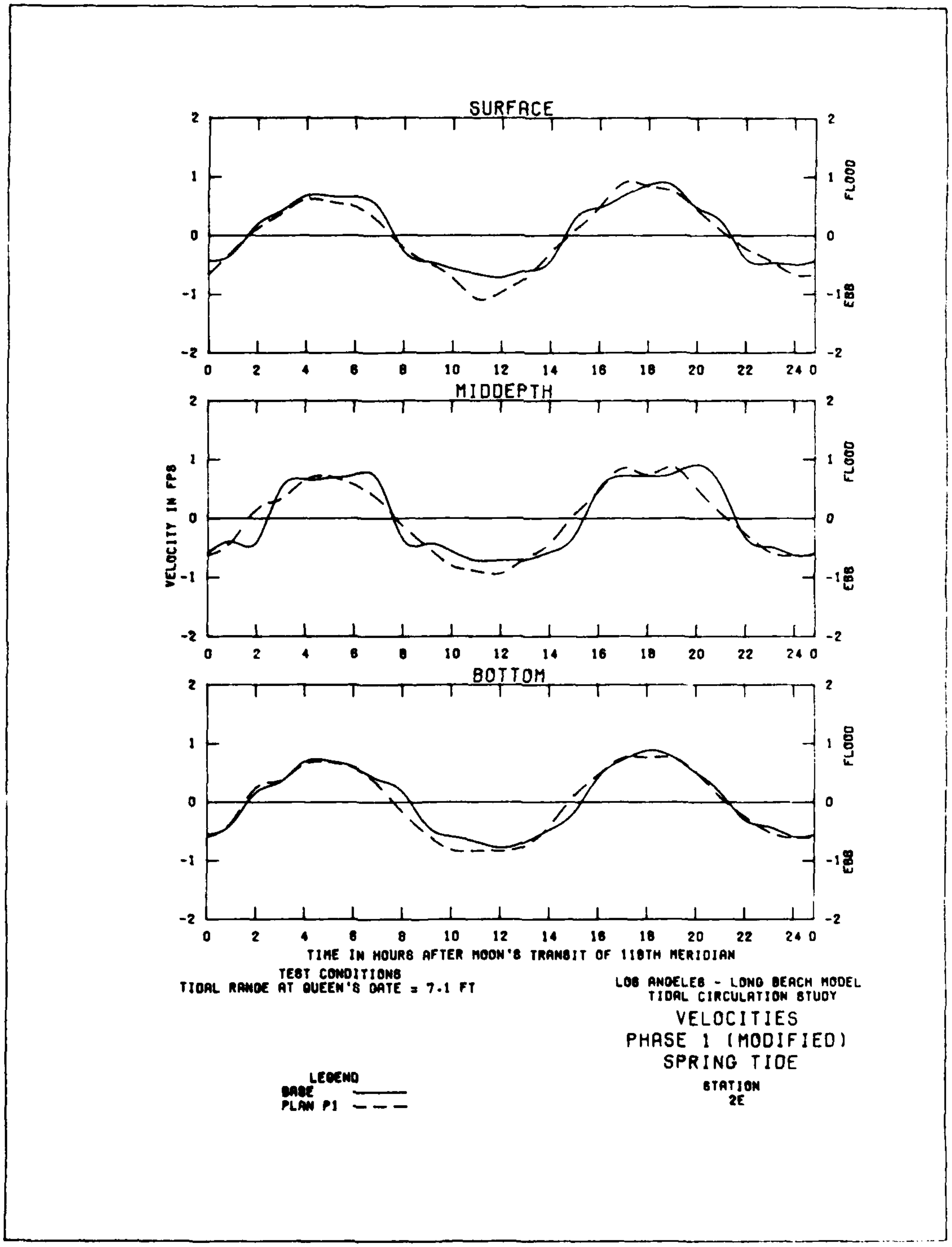


Plate 9

Incl 10

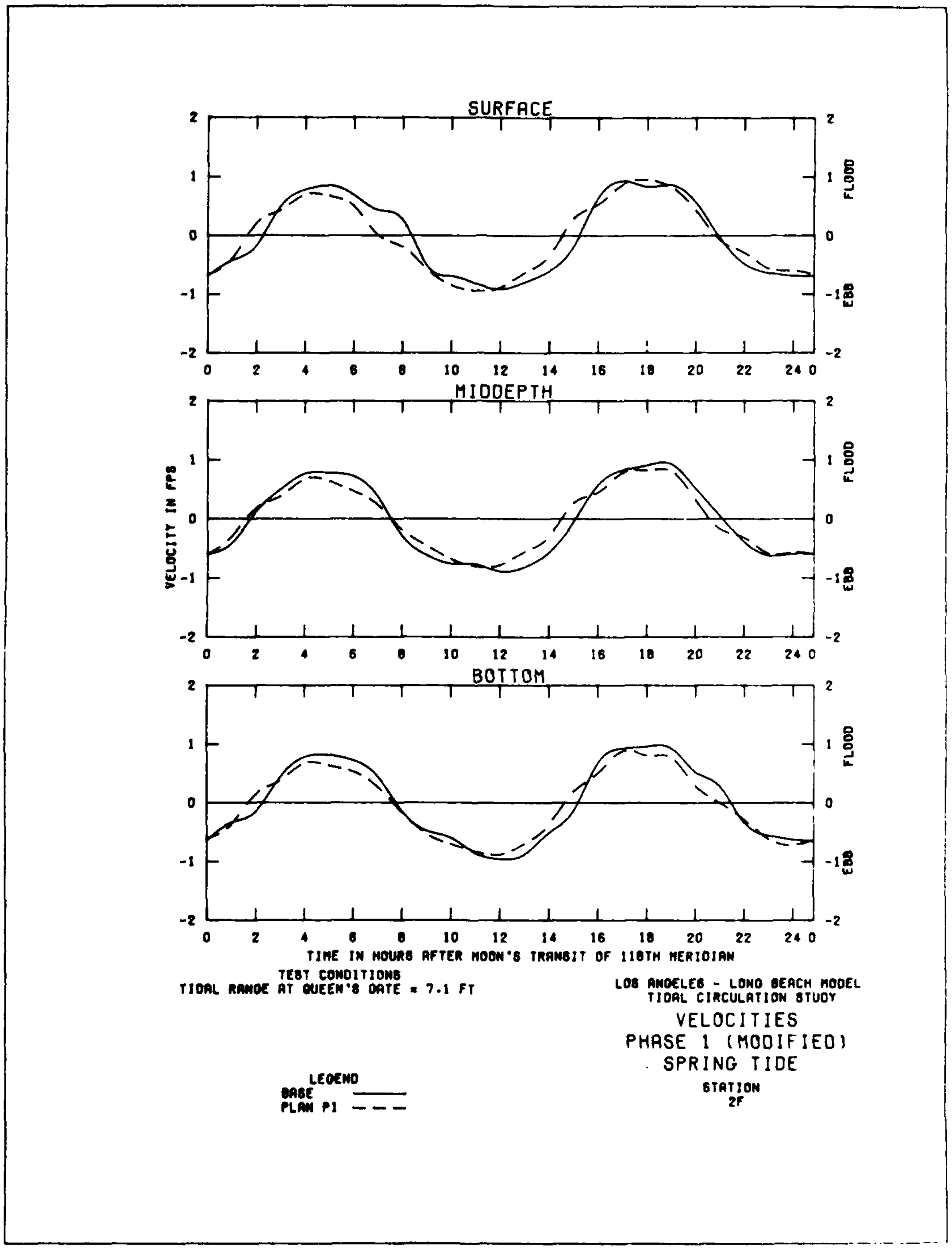
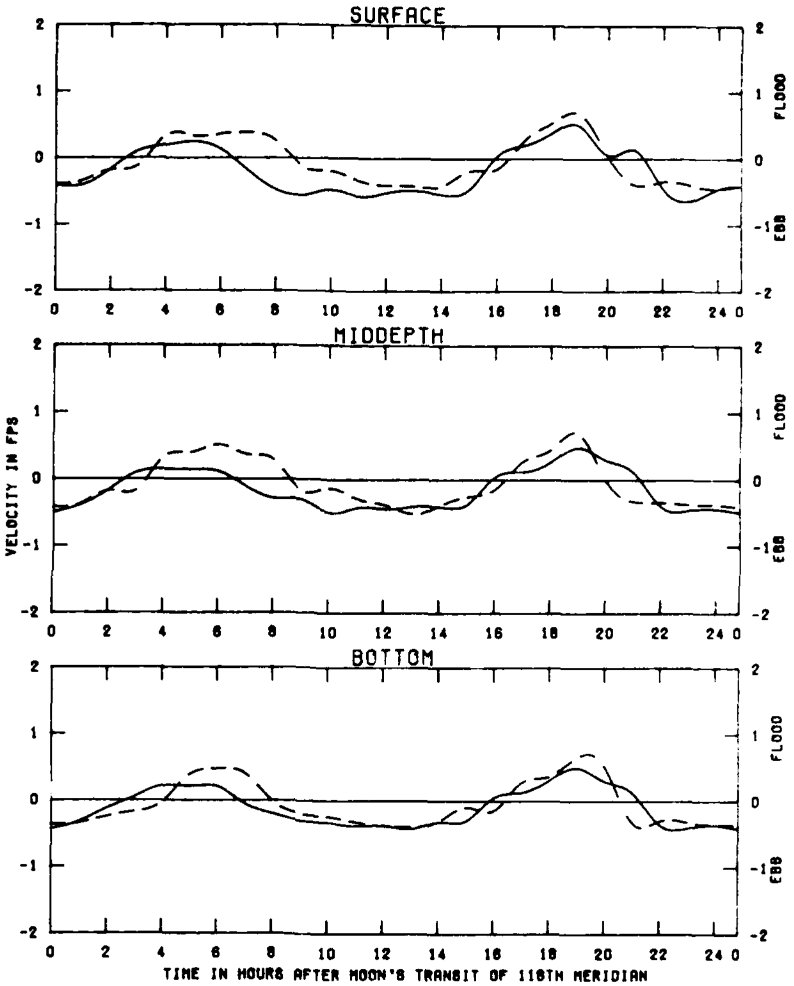


Plate 10

Incl 11



TEST CONDITIONS
TIDAL RANGE AT QUEEN'S GATE = 7.1 FT

LOS ANGELES - LONG BEACH MODEL
TIDAL CIRCULATION STUDY

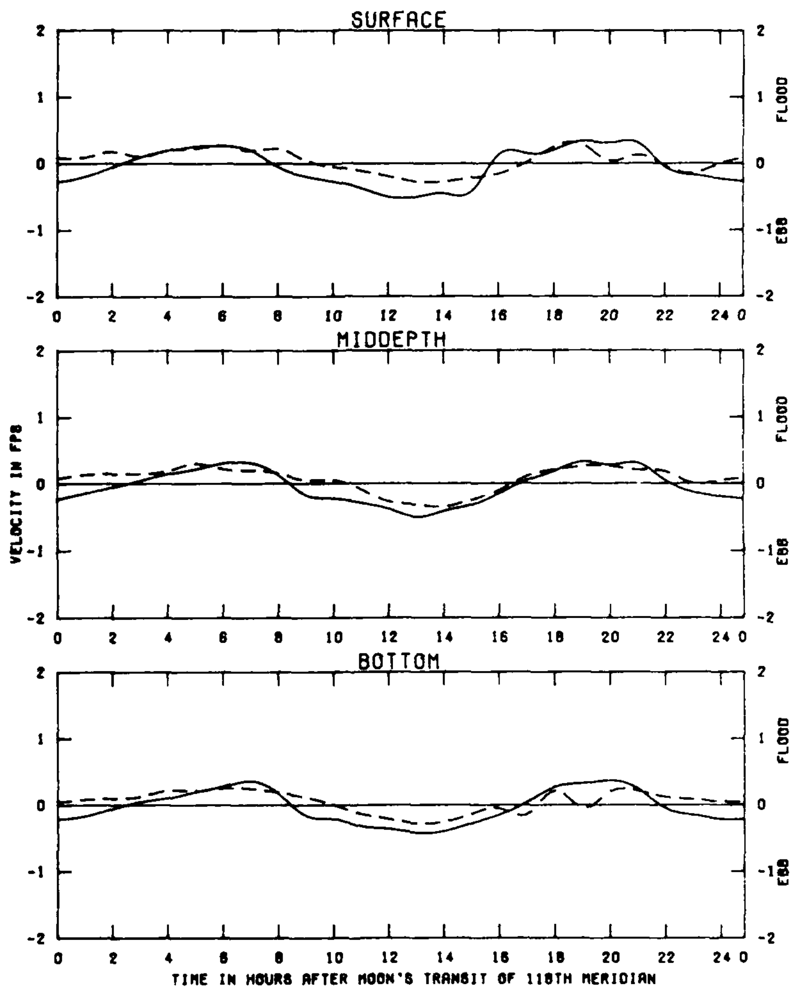
VELOCITIES
PHASE 1 (MODIFIED)
SPRING TIDE

LEGEND
BASE ————
PLAN P1 — — —

STATION
30

Plate 11

Incl 12



TEST CONDITIONS
TIDAL RANGE AT QUEEN'S GATE = 7.1 FT

LOS ANGELES - LONG BEACH MODEL
TIDAL CIRCULATION STUDY

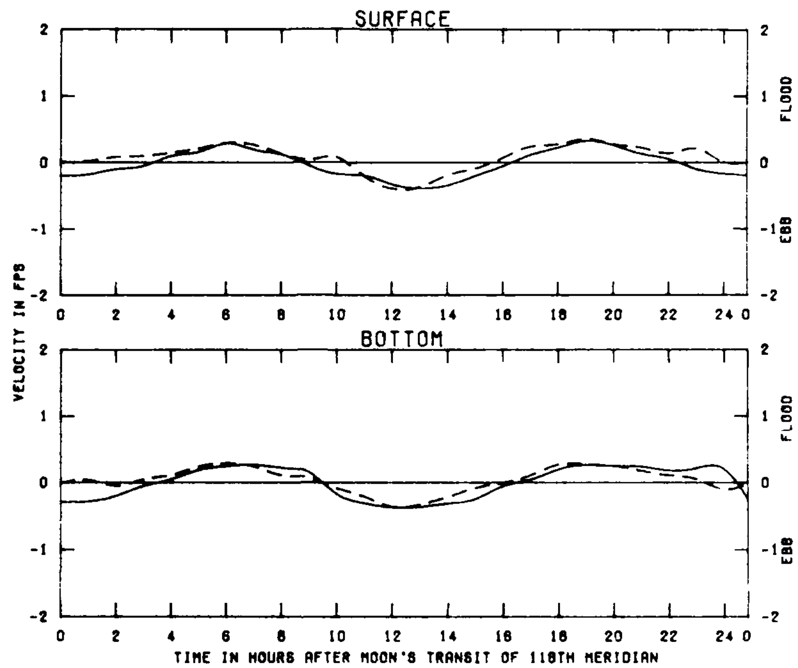
VELOCITIES
PHASE 1 (MODIFIED)
SPRING TIDE

LEGEND
BASE ———
PLAN P1 — — —

STATION
3H

Plate 12

Incl 13



TEST CONDITIONS
TIDAL RANGE AT QUEEN'S GATE = 7.1 FT

LEGEND
BASE ———
PLAN P1 — — —

LOS ANGELES - LONG BEACH MODEL
TIDAL CIRCULATION STUDY
VELOCITIES
PHASE 1 (MODIFIED)
SPRING TIDE
STATION
31

Incl 14

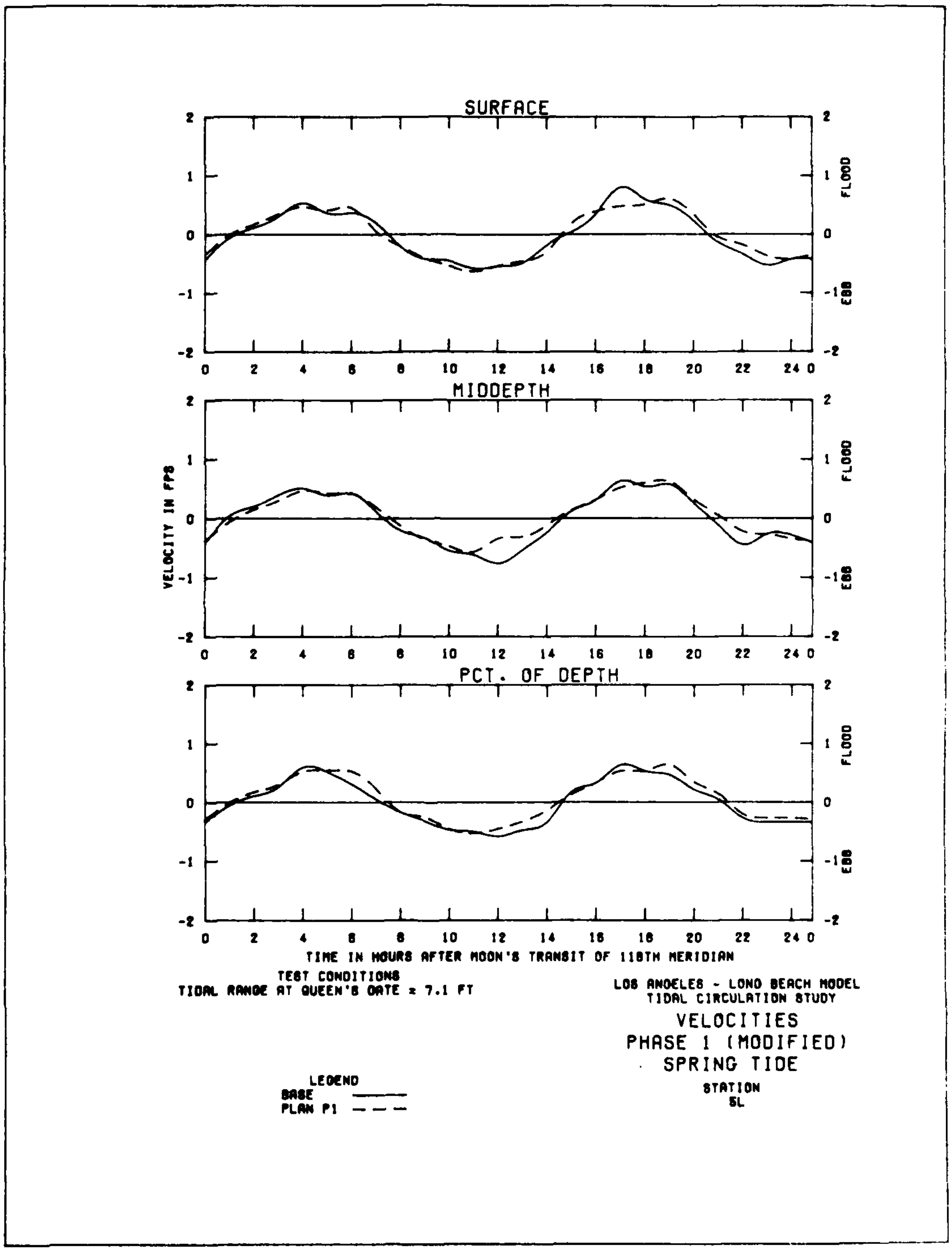
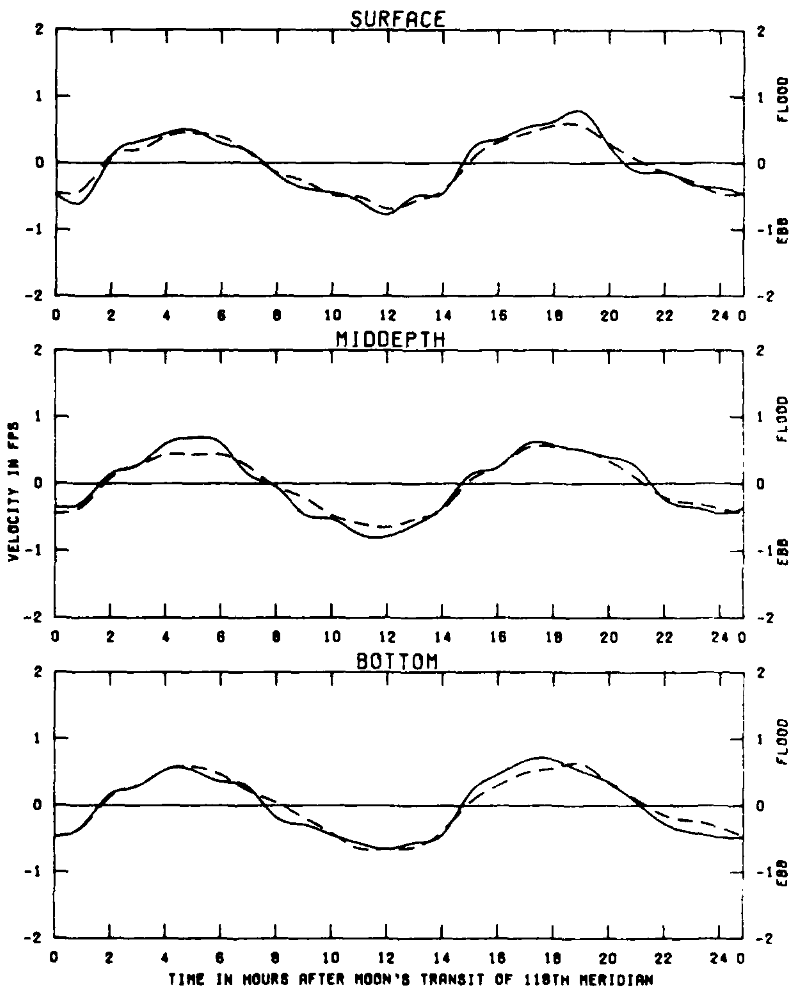


Plate 14

Incl 15



TEST CONDITIONS
TIDAL RANGE AT QUEEN'S GATE = 7.1 FT

LOS ANGELES - LONG BEACH MODEL
TIDAL CIRCULATION STUDY

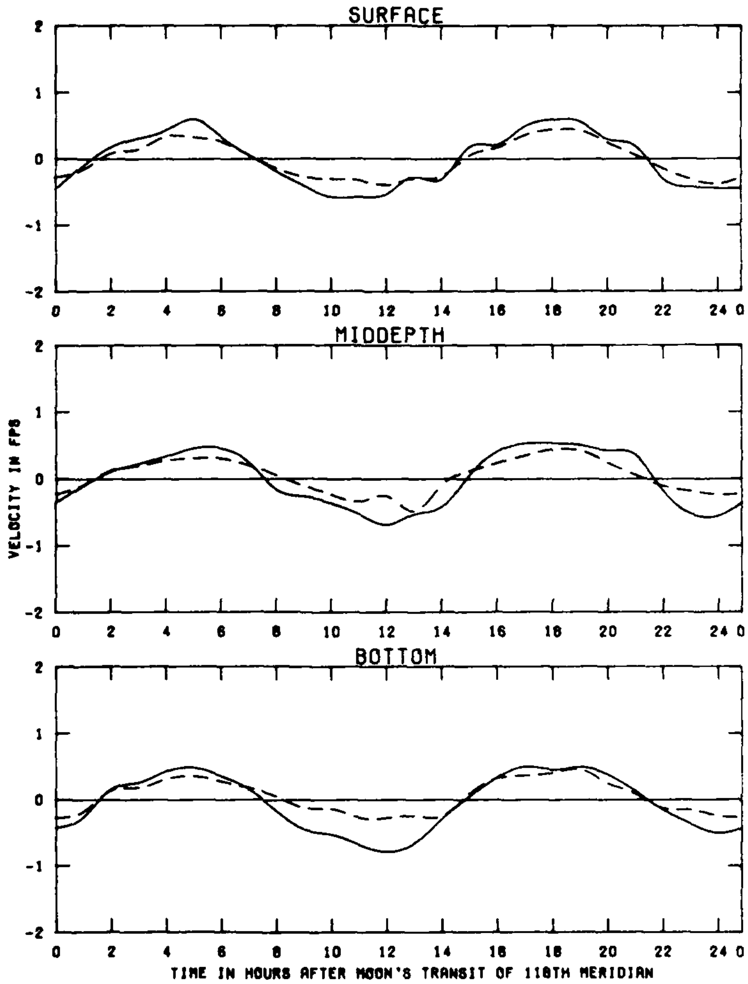
VELOCITIES
PHASE 1 (MODIFIED)
SPRING TIDE

LEGEND
BASE ———
PLAN P1 – – –

STATION
5M

Plate 15

Incl 16



TEST CONDITIONS
TIDAL RANGE AT QUEEN'S GATE = 7.1 FT

LOS ANGELES - LONG BEACH MODEL
TIDAL CIRCULATION STUDY

VELOCITIES
PHASE 1 (MODIFIED)
SPRING TIDE

STATION
5N

LEGEND
BASE ———
PLAN P1 – – –

Plate 16

Incl 17

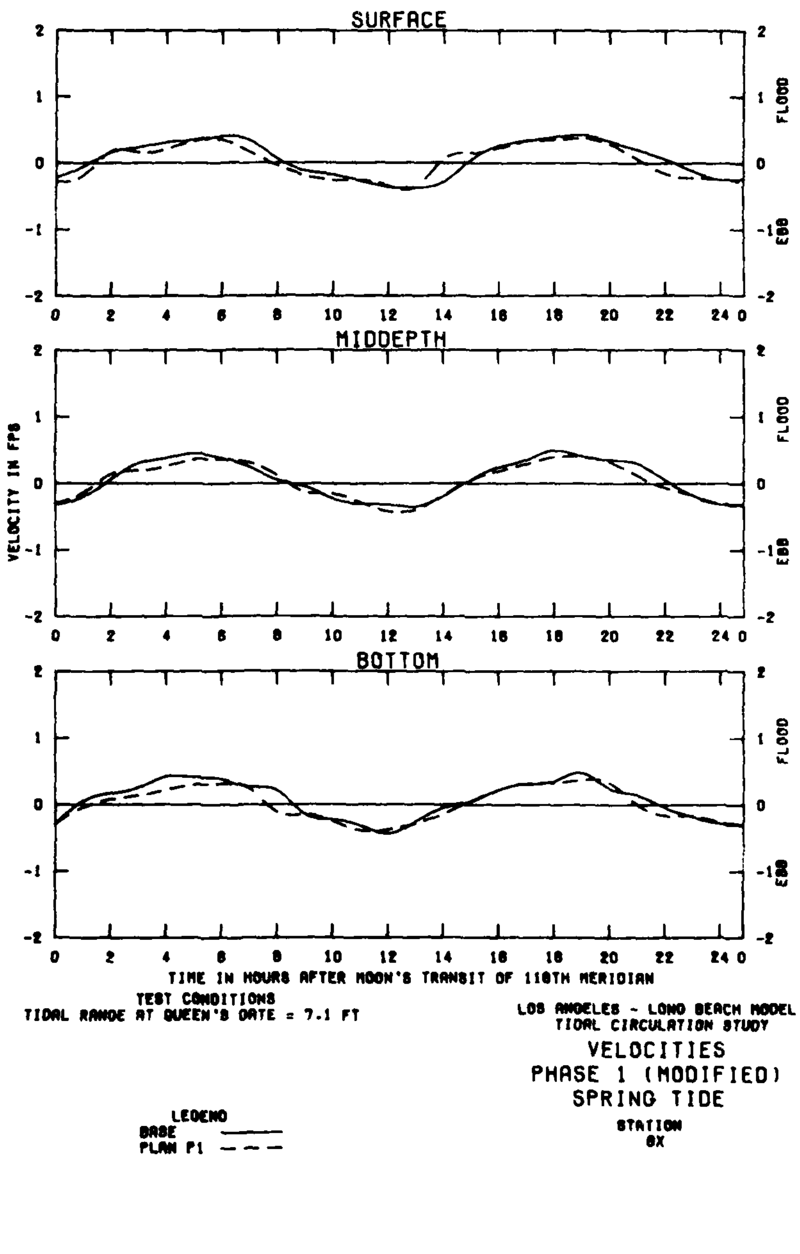
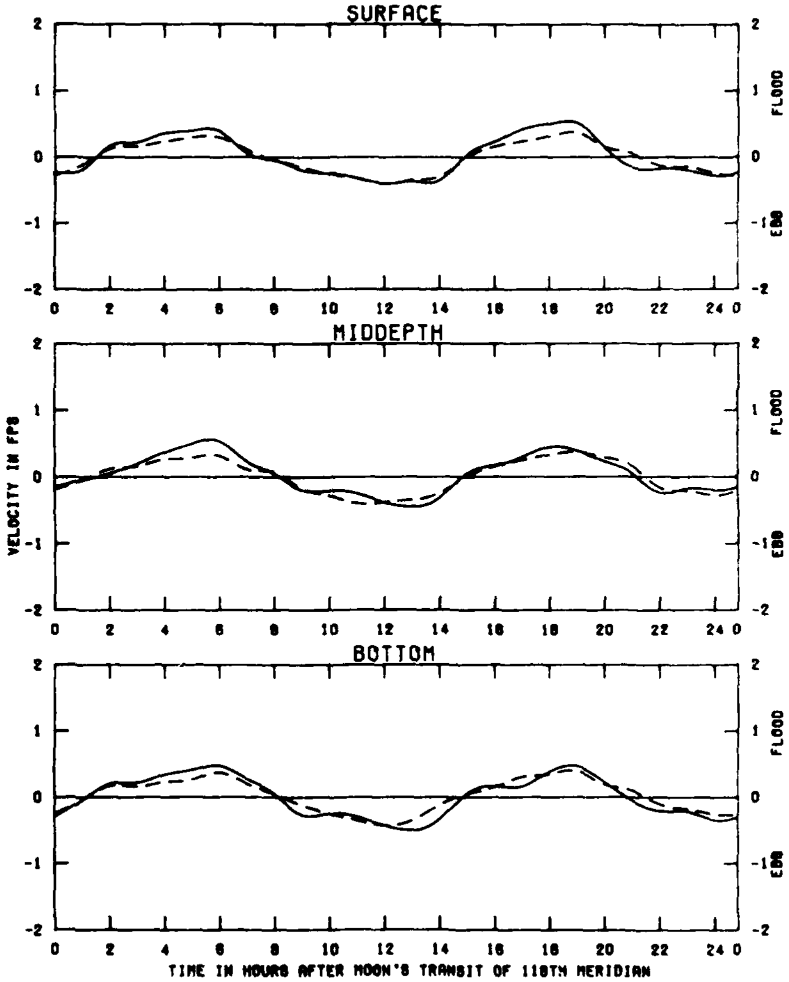


Plate 17

Incl 18



TEST CONDITIONS
TIDAL RANGE AT QUEEN'S GATE = 7.1 FT

LOS ANGELES - LONG BEACH MODEL
TIDAL CIRCULATION STUDY

VELOCITIES
PHASE 1 (MODIFIED)
SPRING TIDE

STATION
9Y

LEGEND
BASE ———
PLAN P1 – – –

Incl 19

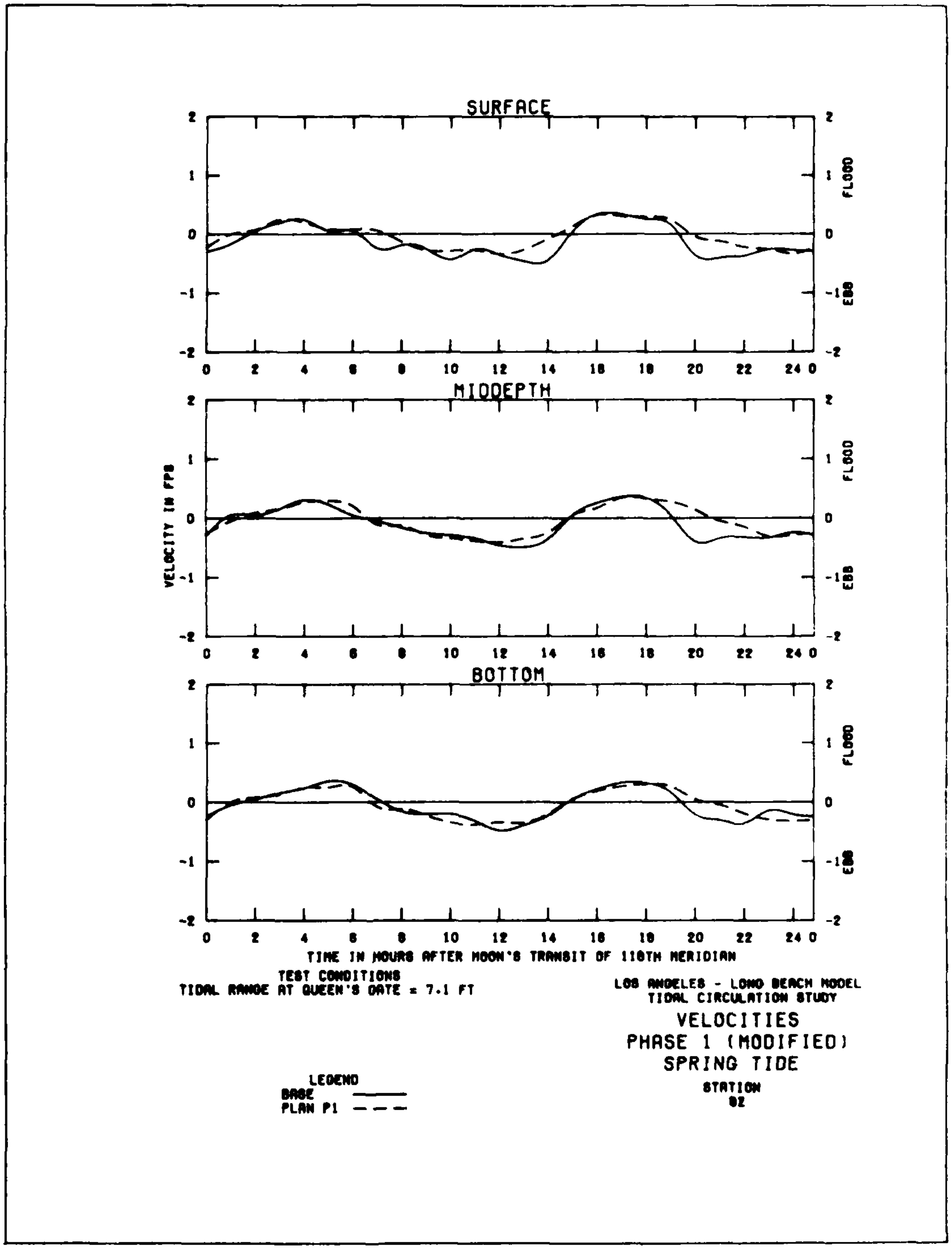
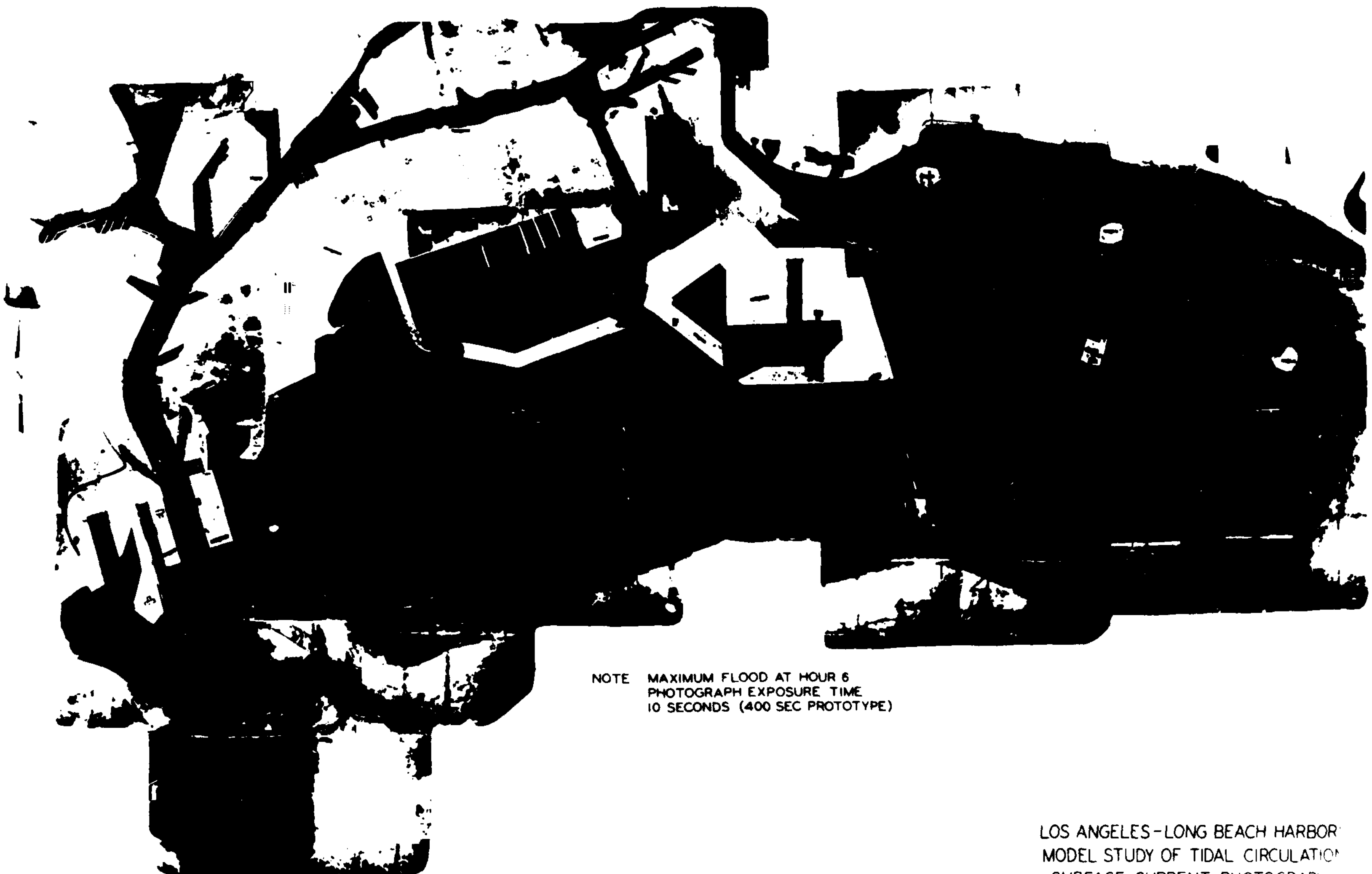


Plate 19

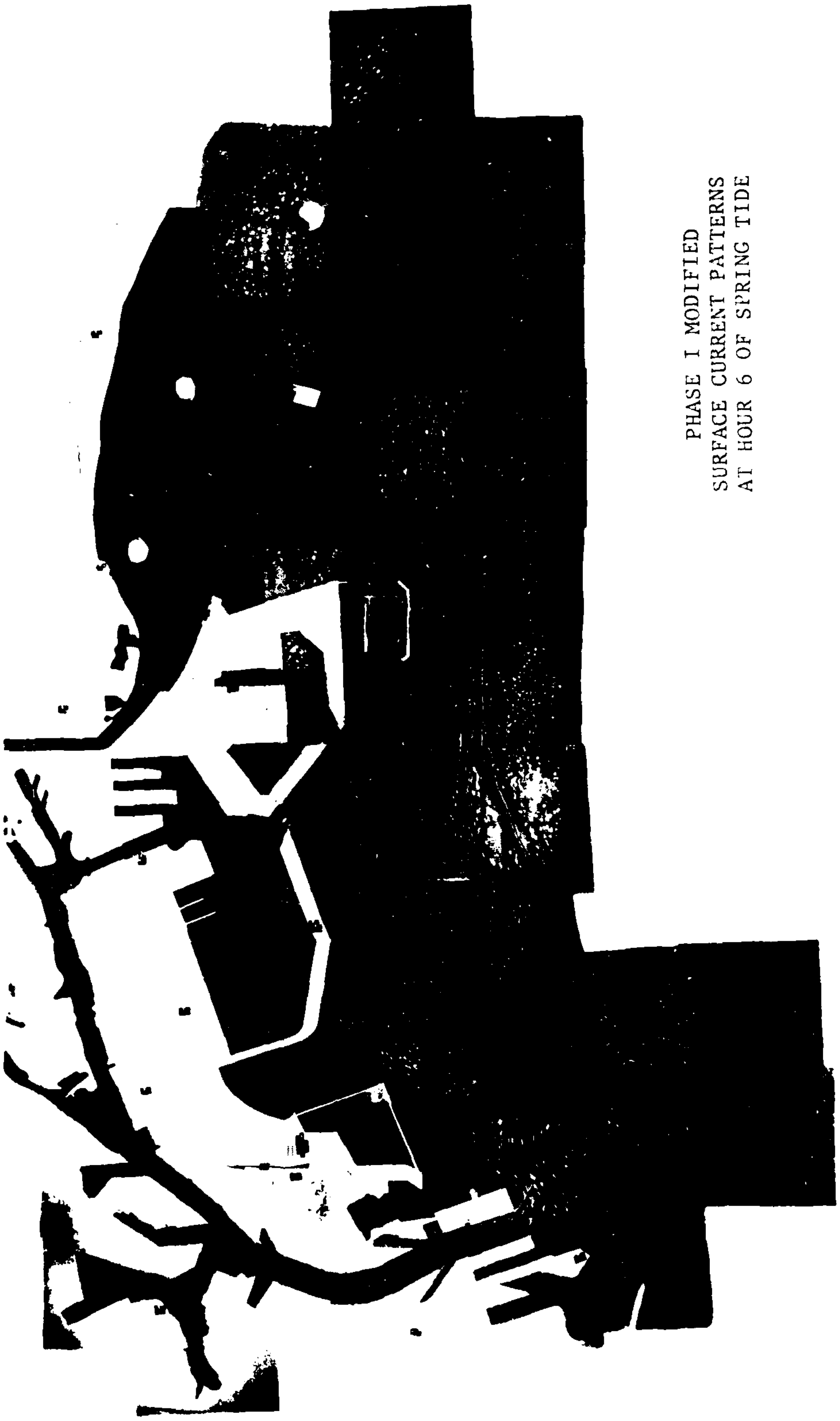
Incl 20



NOTE MAXIMUM FLOOD AT HOUR 6
PHOTOGRAPH EXPOSURE TIME
10 SECONDS (400 SEC PROTOTYPE)

LOS ANGELES-LONG BEACH HARBOR
MODEL STUDY OF TIDAL CIRCULATION
SURFACE CURRENT PHOTOGRAPH
SPRING TIDE

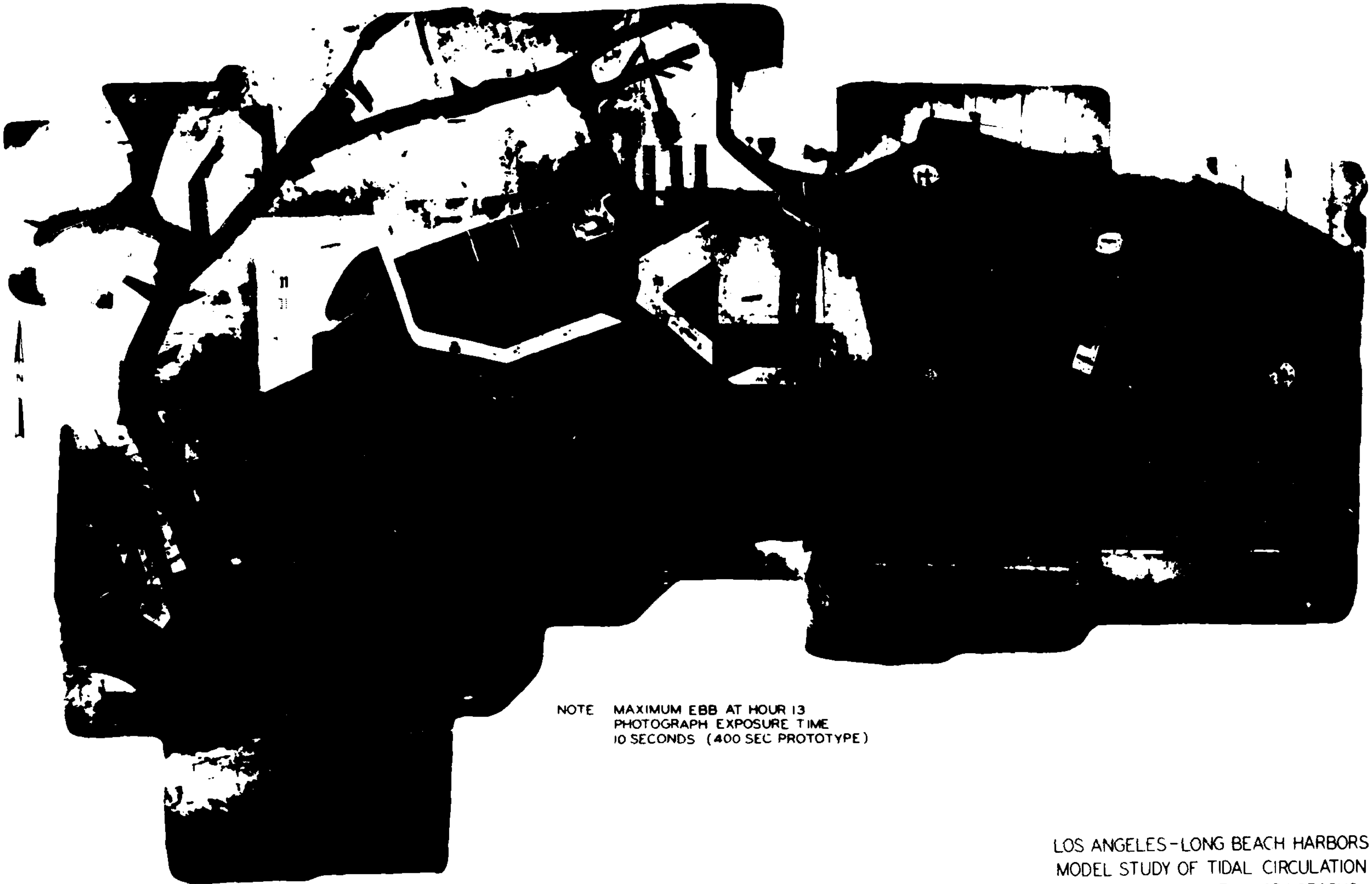
Incl 21



PHASE I MODIFIED
SURFACE CURRENT PATTERNS
AT HOUR 6 OF SPRING TIDE

Plate 21

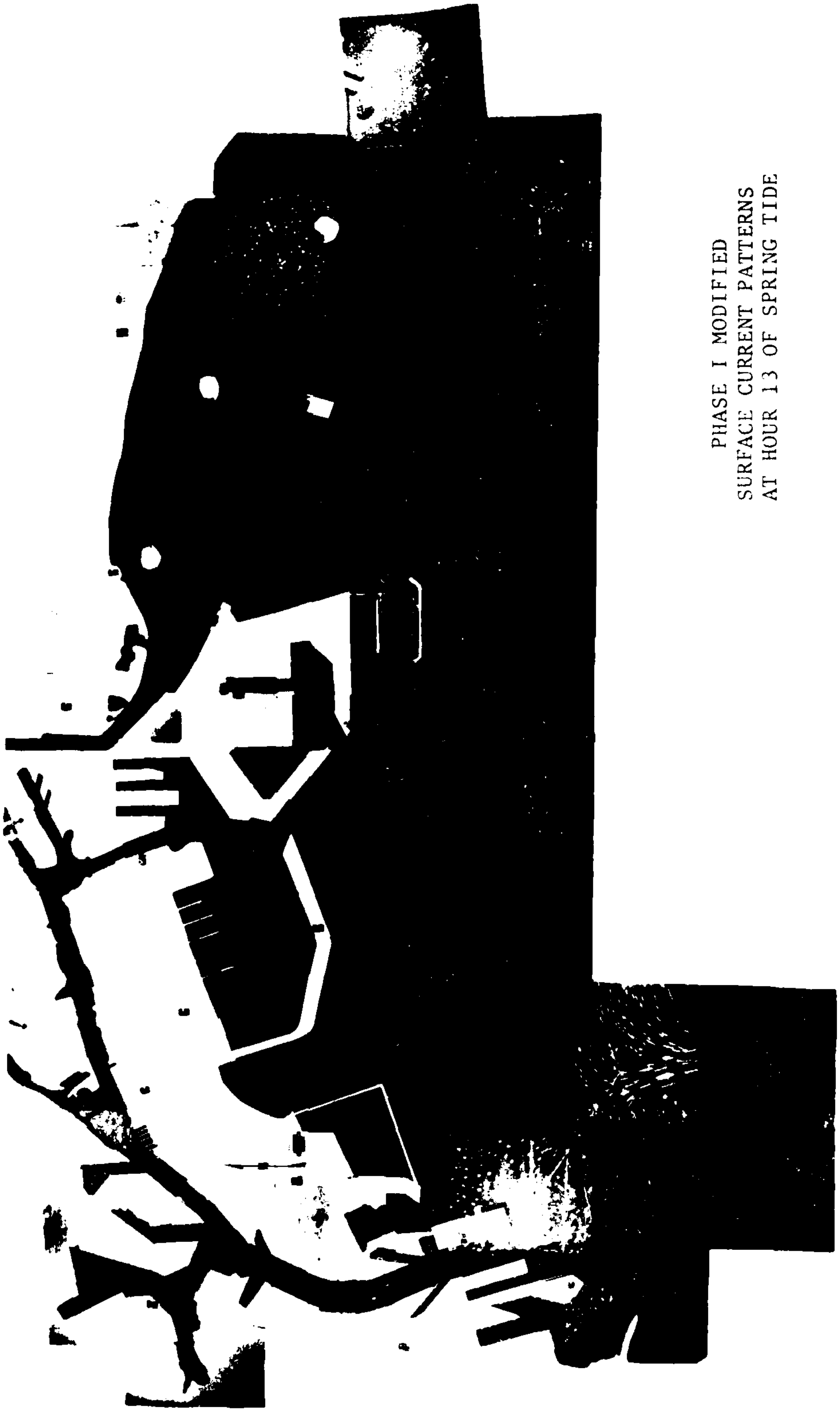
Incl 22



NOTE MAXIMUM EBB AT HOUR 13
PHOTOGRAPH EXPOSURE TIME
10 SECONDS (400 SEC PROTOTYPE)

LOS ANGELES-LONG BEACH HARBORS
MODEL STUDY OF TIDAL CIRCULATION
SURFACE CURRENT PHOTOGRAPHS
SPRING TIDE

Incl 23



PHASE I MODIFIED
SURFACE CURRENT PATTERNS
AT HOUR 13 OF SPRING TIDE

Plate 23

Incl 24

APPENDIX E

HARBOR OSCILLATION TESTS

TECHNICAL REPORT HL-75-4

LOS ANGELES AND LONG BEACH HARBORS MODEL STUDY

Report 6

RESONANT RESPONSE OF THE MODIFIED PHASE I PLAN

by

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Report 6 of a Series

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A study of harbor resonance due to long-period wave excitation was conducted in the Los Angeles and Long Beach Harbors hydraulic model for the Modified Phase I improvement plan and compared with resonant response for existing conditions. Proposed improvements for the Modified Phase I plan included dredging of navigation channels and an associated landfill of approximately 200 acres in the Port of Los Angeles, and an Outer Harbor Oil Terminal in the Port of Long Beach.

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20. ABSTRACT (Continued).

Wave periods ranging from 15.5 to 410 sec with incident direction of approach from the south were included in the study. Previous refraction studies had shown that due to offshore topography, Los Angeles and Long Beach Harbors are well protected from all incident long-period wave directions, except from the south. Results of the study show wave-height amplification, periods of maximum response, and modes of oscillation for various berthing areas. Comparisons of model data for existing conditions and the proposed plan indicated that resonant modes of oscillation in the existing harbor berthing areas were not substantially altered. With the Modified Phase I plan, periods of maximum resonant amplification in existing harbors generally shifted slightly. Resonant peaks in the amplification data generally decreased or increased slightly. For existing conditions, periods of maximum response agreed closely with prototype measurements. In the proposed Outer Harbor Oil Terminal, modes of oscillation either resulted in antinodes in the berthing areas or had relatively low amplification.

PREFACE

The Los Angeles and Long Beach Port Authorities plan to construct additional harbor basins and dredge deeper channels and harbor areas to meet growing future demands for expansion of ship mooring facilities. In this report, the sixth in a series to be published under the general title "Los Angeles and Long Beach Harbors Model Study," the results of a harbor resonance study conducted in the Los Angeles and Long Beach Harbors hydraulic model are given.

Project administration and funding were provided by the U. S. Army Engineer District, Los Angeles (SPL), under project management of Messrs. J. Chapman, H. Converse, T. Nizinski, and D. Muslin and under the general direction of Messrs. G. Fuquay, former Chief of the Engineering Division, T. Nishihara, Chief of the Engineering Division, and C. H. Fisher, Chief of the Coastal Resources Branch. COL R. J. Malley, CE, COL J. V. Foley, CE, COL H. G. Robinson, CE, and COL G. A. Teague, CE, were District Engineers of SPL during the course of this study. General project administration for the U. S. Army Engineer Division, South Pacific, was provided by Messrs. O. F. Weymouth, O. T. Magoon, J. W. Gerhart, and A. E. Wanket.

The model study was conducted by the U. S. Army Engineer Waterways Experiment Station (WES), in the Hydraulics Laboratory, under the general supervision of Messrs. H. B. Simmons and F. A. Herrmann, Jr., Chief and Assistant Chief, respectively, of the Hydraulics Laboratory; Dr. R. W. Whalin, Chief of the Wave Dynamics Division, and Mr. C. E. Chatham, Chief of the Wave Processes Branch (WPB). This report was prepared by Mr. D. G. Outlaw, WPB. The model wave tests were conducted by Mr. Outlaw with the assistance of Messrs. K. A. Turner, L. A. Barnes, and W. Reynolds and Ms. J. Jones.

Directors of WES during the model design and the preparation and publication of this report were BG E. D. Peixotto, CE, COL G. H. Hilt, CE, COL John L. Cannon, CE, and COL Nelson P. Conover, CE. Technical Director was Mr. F. R. Brown.

CONTENTS

CONVERSION FACTORS, U. S. CUSTOMARY TO METRIC (SI) UNITS OF MEASUREMENT

U. S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	By	To Obtain
acres	4046.856	square metres
feet	0.3048	metres
inches	25.4	millimetres
miles (U. S. statute)	1.609344	kilometres
square feet	0.09290304	square metres
square miles (U. S. statute)	2.589988	square kilometres

LOS ANGELES AND LONG BEACH HARBORS MODEL STUDY

RESONANT RESPONSE OF THE MODIFIED PHASE I PLAN

PART I: INTRODUCTION

Background and Model Study Objectives

1. Historically, the ports of Los Angeles and Long Beach have experienced long-period surge activity which sometimes causes mooring problems for ships berthed in some locations within the harbors complex. Development of the harbors and past resonance characteristics of the harbors have been reviewed in detail as a portion of a study[1] completed by Science Engineering Associates for the U. S. Army Engineer District, Los Angeles. The ports are located on San Pedro Bay along the southern coast of California. A location map and the existing harbor configuration are shown in Figure 1.

2. The model investigation reported herein was conducted as a part of the Los Angeles and Long Beach Harbors study which included the following four major objectives:

- a. Determine the incidence and severity of troublesome oscillations in the present harbor complex.
- b. Investigate the tidal circulation characteristics of the present and proposed harbors.
- c. Determine the optimum plan for future expansions to provide safe and economical berthing areas.
- d. Analyze the effect proposed expansions will have on existing harbors.

3. Prototype wave, tide, and ship motion data[2,3] were acquired over a 1-yr period in the harbor. Analyses of prototype wave and ship motion data are described in Reference 4.

4. In the existing harbors, troublesome ship mooring conditions are occasionally experienced in East Channel of the Port of Los Angeles and in Southeast Basin of the Port of Long Beach, along the edge of Pier J, and near the west end of Basin 6. The location of the city

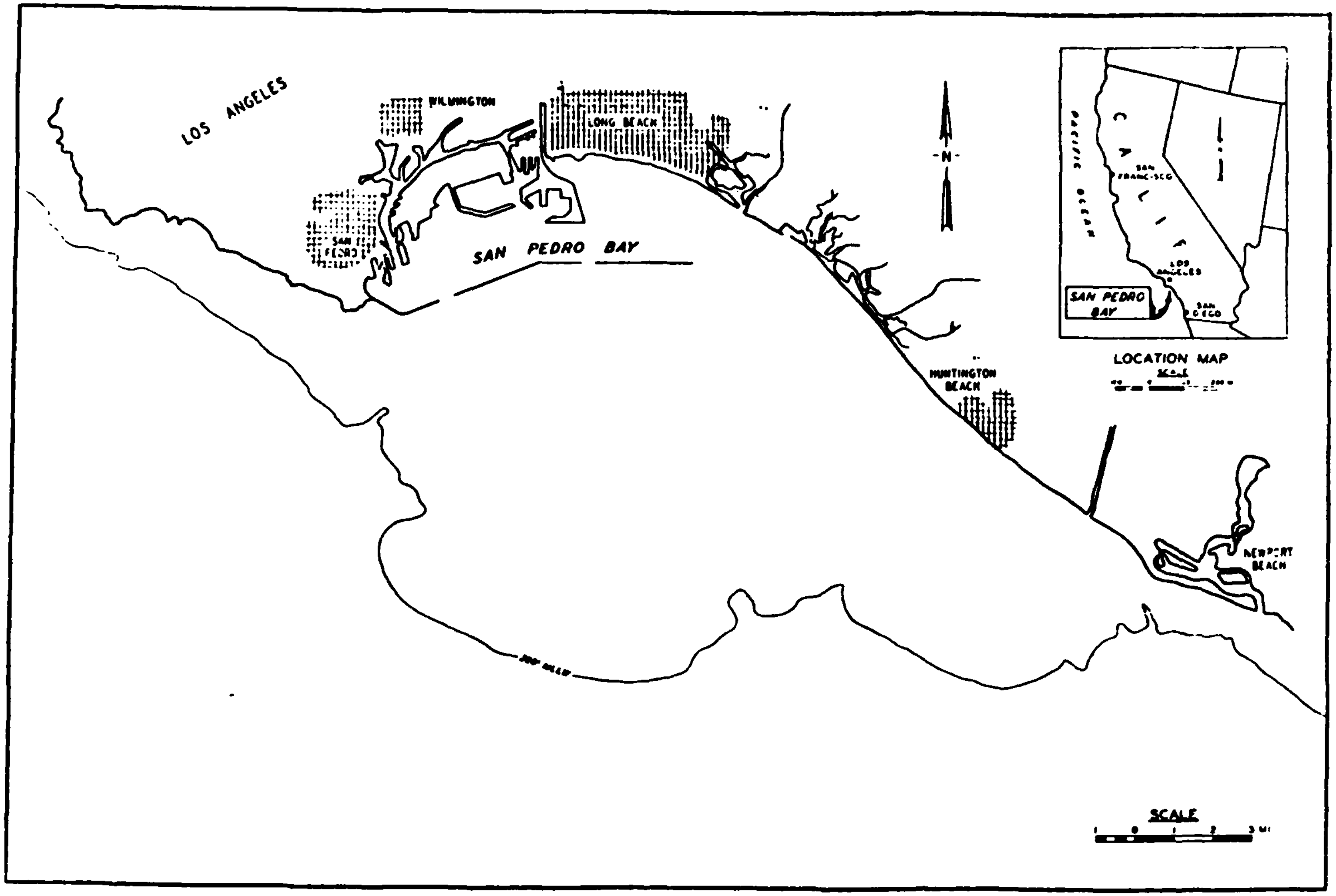

Figure 1. Site map

boundary and various channels and basins in the harbors are shown in Figure 2.

5. The hydraulic model investigation of harbor resonance for the Modified Phase I plan was conducted to satisfy portions of objectives 2c and 2d. A careful examination of the effect of proposed improvements is necessary to ensure that the optimal cost-effective plan is developed consistent with minimizing the potential for undesirable effects which could prove either irreversible or extremely costly to correct.

Proposed Improvements

6. The proposed improvement plan is shown in Figure 3. The proposed improvements in the Port of Los Angeles include:

a. Increasing the depth from 35 ft* to 45 ft referred to mean lower low water (mllw) in the Los Angeles main channel, West Basin, East Basin, and East Basin channel.

b. Dredging to -45 ft mllw along the northeast side of the Los Angeles entrance channel to provide a 1000-ft-wide channel.

c. A dredged material landfill of approximately 200 acres adjacent to Terminal Island east of Fish Harbor.

In the Port of Long Beach, the proposed improvements will provide an Outer Harbor Oil Terminal adjacent to Pier J and will include:

a. Increasing the depth of the Long Beach entrance channel from a controlling depth of 60 ft mllw to 65 ft mllw.

b. An impervious breakwater along the southern side of the oil terminal to provide protection against waves entering the harbor through Queen's Gate.

c. A 2000-ft-long impervious dike along the north side of the channel in the oil terminal.

d. Trestle from Pier J to three oil terminal berths.

Those harbor improvements are referred to as the Modified Phase I plan. The initial Phase I plan included a landfill of approximately 55 acres

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* A table of factors for converting U. S. customary units of measurement to metric (SI) units is presented on page 3.

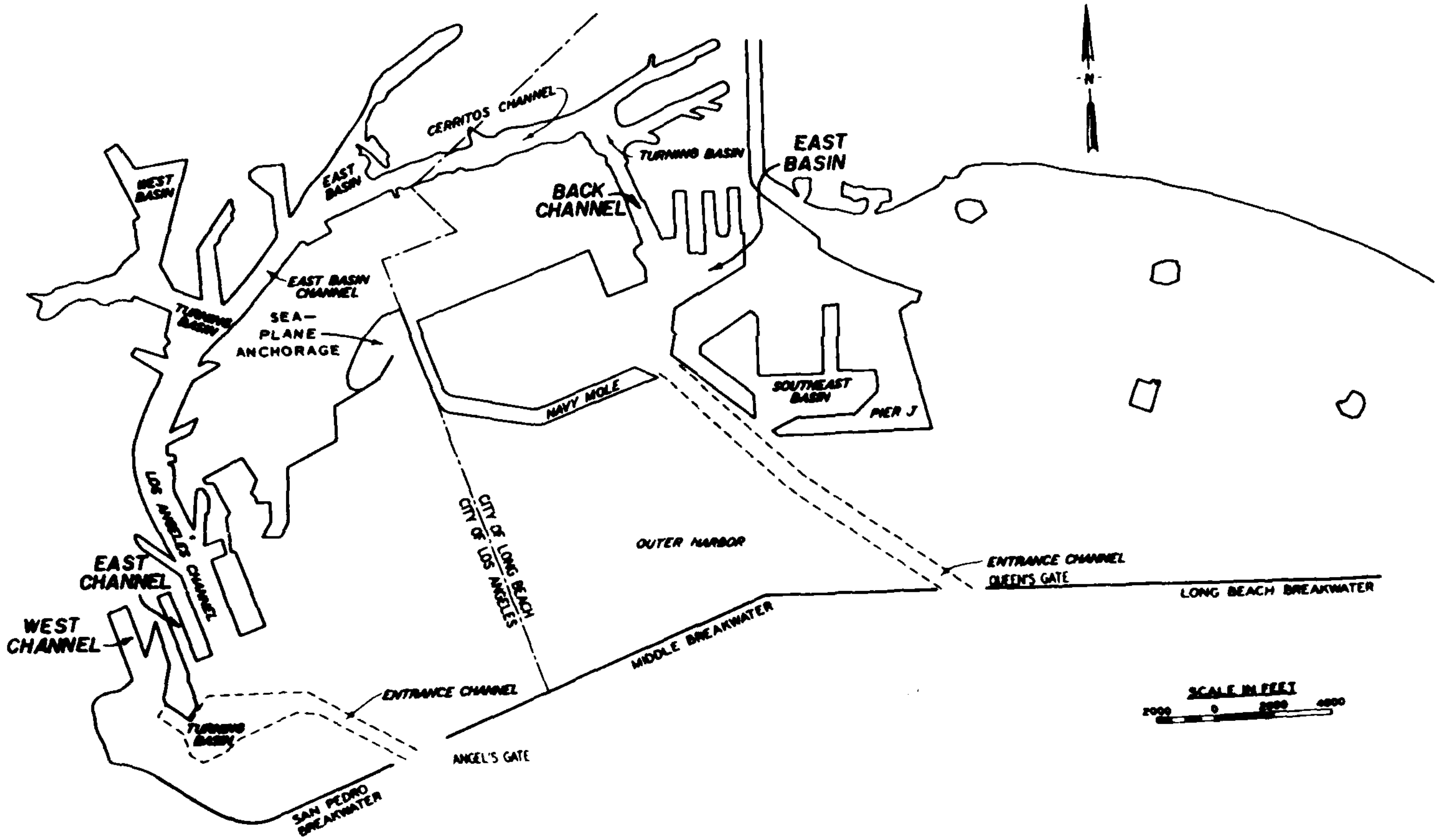

Figure 2. Location of city boundary and various channels and basins in the Los Angeles and Long Beach Harbors

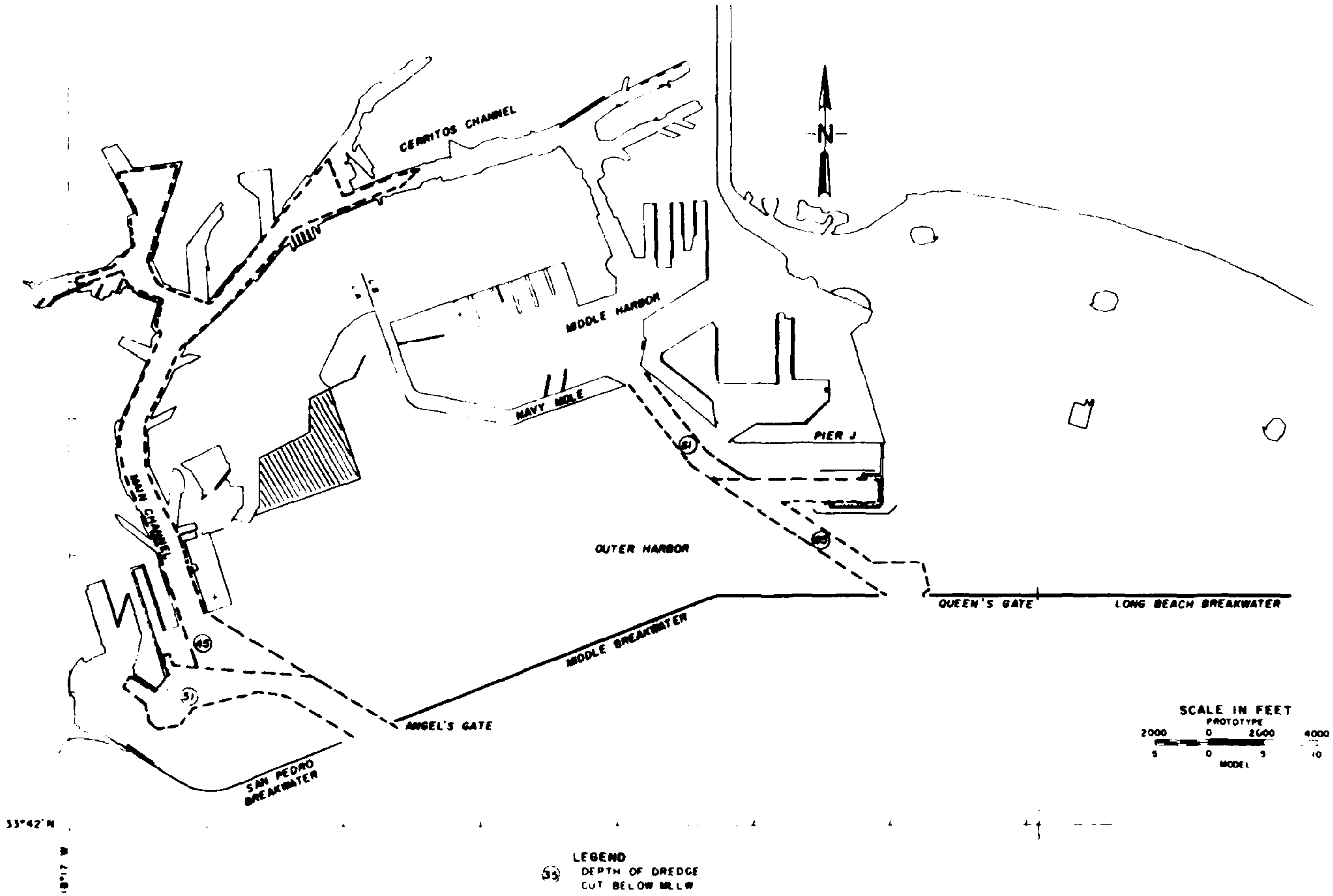

Figure 3. Elements of the proposed Modified Phase I plan

near the northwest tip of Pier J as a part of the proposed Long Beach Outer Harbor Oil Terminal, but this landfill was not included in the Modified Phase I plan. Element 6c, the 2000-ft-long dike, was added after a strong cross-channel oscillation developed in the oil terminal during initial wave tests of the Phase I plan at a period of approximately 2 min.

Associated Model Tests

7. An investigation of tidal circulation for the Modified Phase I plan was started in the hydraulic model after completion of the wave test series. A two-dimensional breakwater stability study sponsored by the Port of Long Beach for design of the Outer Harbor Oil Terminal breakwater also was conducted at the U. S. Army Engineer Waterways Experiment Station (WES). Results of these investigations will be published in separate reports.

PART II: MODEL DESIGN

Model Description

8. The Los Angeles and Long Beach Harbors hydraulic model was molded in concrete grout and accurately reproduced to scale San Pedro Bay and a portion of the Pacific Ocean surrounding the harbor. The model shoreline extended from approximately 2 miles northwest of Point Fermin to Huntington Beach. Underwater contours were reproduced out to the -300 ft mllw contour, and sufficient additional offshore area was included to provide space for wave generators and the model tide generator. Model limits are shown in Figure 4.

9. The model was constructed to linear scale ratios, model to prototype, of 1:100 vertically and 1:400 horizontally. The model covered approximately 44,000 sq ft, representing 253 square miles of prototype area. Depth data for model contours were obtained from the U. S. Coast and Geodetic Survey (now National Ocean Survey) Charts 5101 and 5147, and from harbor soundings provided by the Ports. Major piers and wharves were reproduced in the model with 1/16- and 1/32-in.-diam brass rods used to simulate pier piling. The bays east of the harbors such as Alamitos Bay and Anaheim Bay were correctly reproduced in plan but depths were averaged in the model in order to expedite construction and, at the same time, to permit proper reproduction of approximate tidal prisms. If future studies in these areas are required, the actual bathymetry can be installed in the model with relative ease.

Design Considerations

10. Comprehensive investigations of the following items were conducted during model design to aid in selection of proper model scales and limits in order to ensure accurate reproduction of long-period wave excitation.

- a. Wave refraction for wave periods of 15 sec to 6 min.
- b. Energy transmission through the breakwaters.

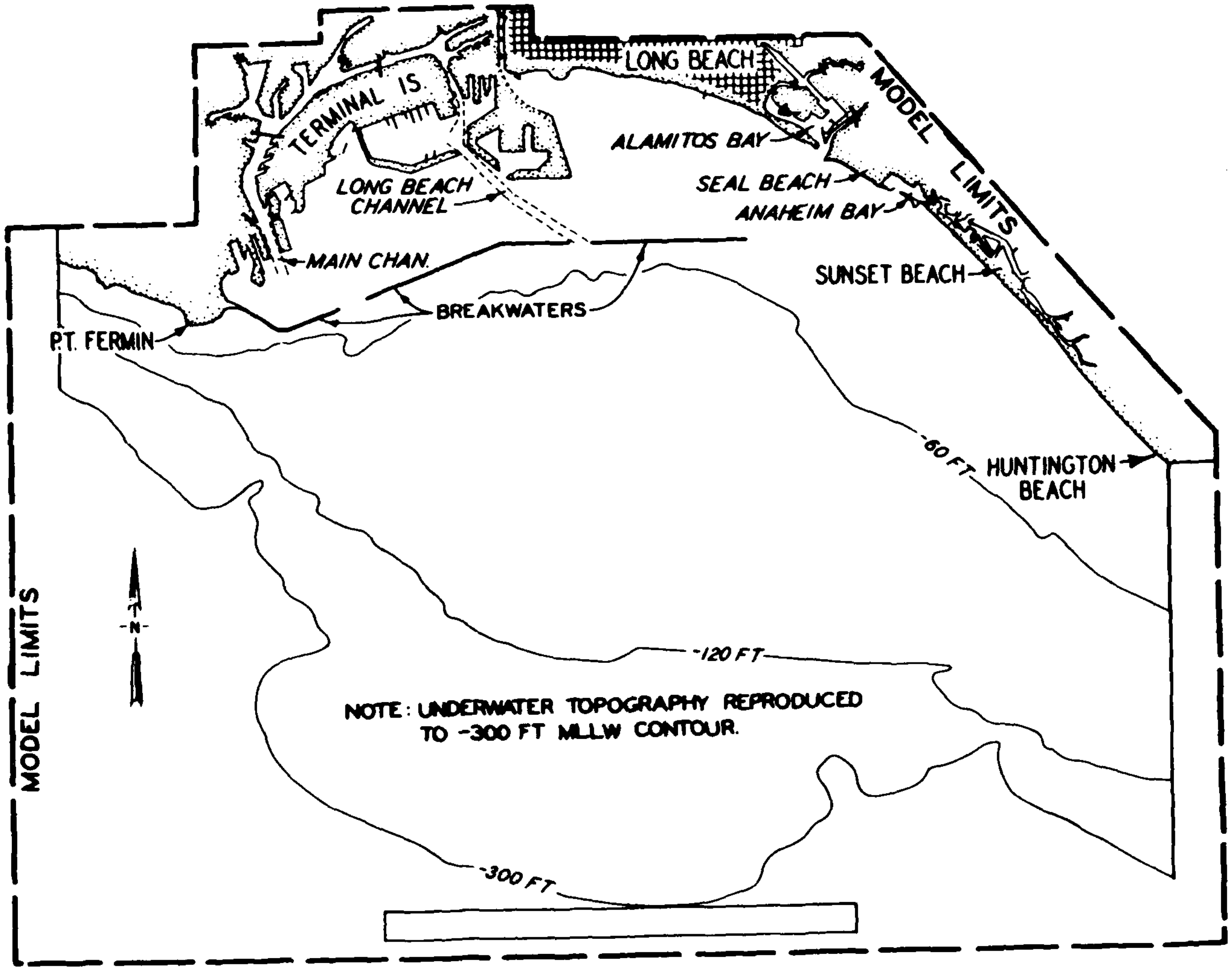

Figure 4. Los Angeles and Long Beach Harbors model

c. Diffraction through the harbor entrances.

d. Reflection from the offshore topography and from harbor boundaries.

e. Model wave filters and absorbers.

f. Model wave-height attenuation.

Details of these investigations are reported in Reference 5.

11. The following conclusions drawn from the model design analysis provide a brief summary of the criteria concerning model limits and scale selection:

a. The harbor is relatively well protected from long-period wave attack except from the south-southeast through the south-southwest.

b. A convergent zone is located seaward of the harbor breakwater for the 15- to 360-sec-period range.

c. A model distortion ratio of 1:4 and a vertical scale ratio of 1:100 were selected to minimize model area and to provide a vertical scale ratio where accurate model measurements could be assured.

d. Near a wave period of 60 sec and below, the calculated refraction patterns for the distorted scale model changed significantly from the calculated prototype refraction patterns, and adjustment of the initial wave front in the model was necessary.

e. Wave-height variation along the prototype wave front is significant and should be reproduced in the wave tests.

The development of the convergent zone is demonstrated in the wave refraction diagram for a 60-sec wave period from the south shown in Figure 5.

12. The time scale for wave period is based on the following equation:

$$T_m = T_p \left(\frac{\ell_{hm}}{\ell_{hp}} \right)^{1/2} \left[\frac{\tanh \frac{2\pi}{\Omega} \frac{h_m}{L_m}}{\tanh 2\pi \frac{h_m}{L_m}} \right]^{1/2} \qquad (1)$$

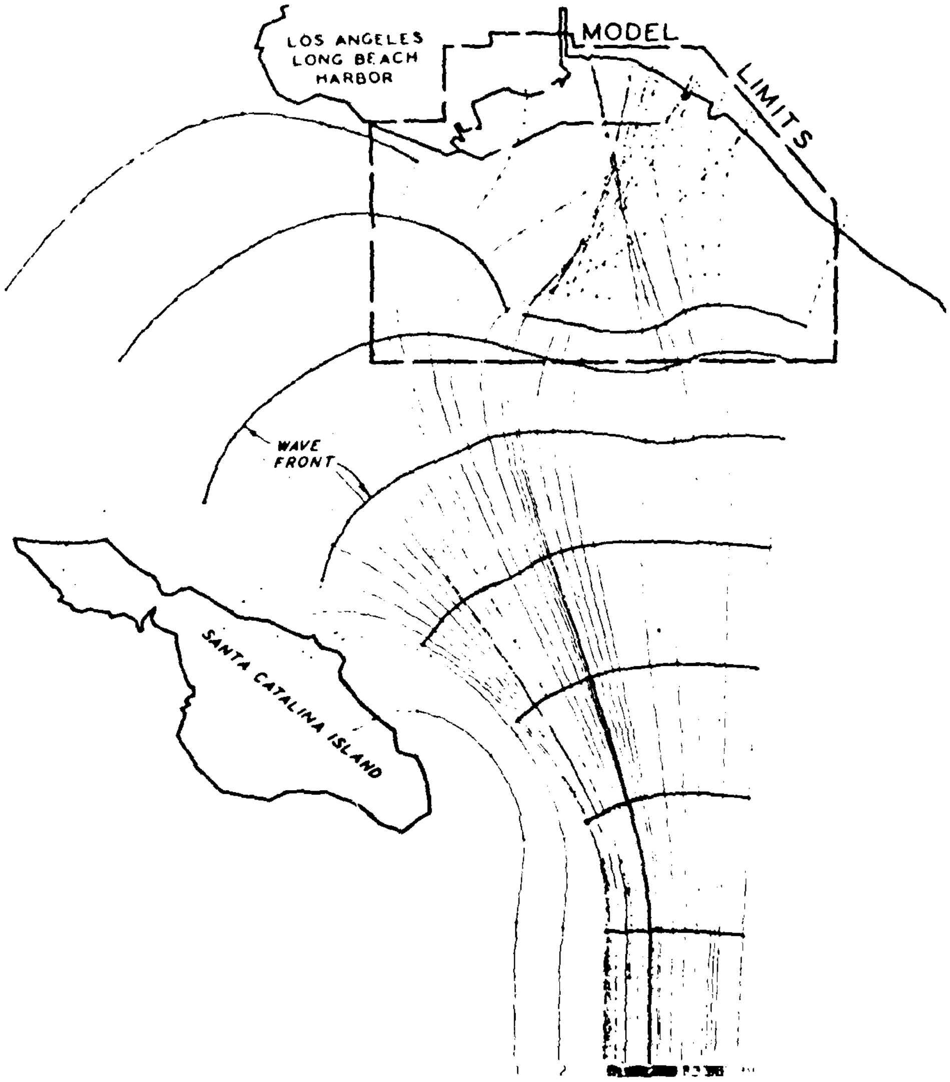

Figure 5. Refraction diagram for 60-sec wave from the south

where

T_m = model wave period*

T_p = prototype wave period

ℓ_{hm} = horizontal length scale in the model

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* For convenience, symbols and unusual abbreviations are listed and defined in the Notation (Appendix A).

ℓ_{hp} = horizontal length scale in the prototype

Ω = distortion

h_m = model depth of the inner harbor

L_m = model wavelength

Equation 1 is based on similitude of wavelength between model and prototype which is the proper requirement for harbor resonance studies. In the limit as L_m , $L_p \rightarrow \infty$, Equation 1 approaches

$$T_m \approx T_p \left[\frac{\ell_{hm}}{\Omega \ell_{hp}} \right] \tag{2}$$

For an average existing harbor depth of 39 ft, the approximate model wave period calculated from Equation 2 is within 1 percent of the period calculated from Equation 1 for prototype periods $\geq$ 85 sec. At shorter periods, the dependence of the time scale on depth increases and the accuracy of the approximation represented by Equation 2 decreases.

Model Appurtenances

Wave generator

13. The model was equipped with an electrohydraulic wave generator capable of:

- a. Generating waves with a prototype period ranging from 15 to 360 sec.
- b. Generating a wave with small variation in period and height.
- c. Defining resonant response occurring over a narrow period band by controlling the model wave period with great precision.
- d. Generating a variable wave height along a curved wave front.

The wave generator was composed of 14 units, each with a 15-ft wave paddle, for a total length of 210 ft. The 15-ft sections may be positioned to approximate a curved wave front, as indicated in Figure 6 for

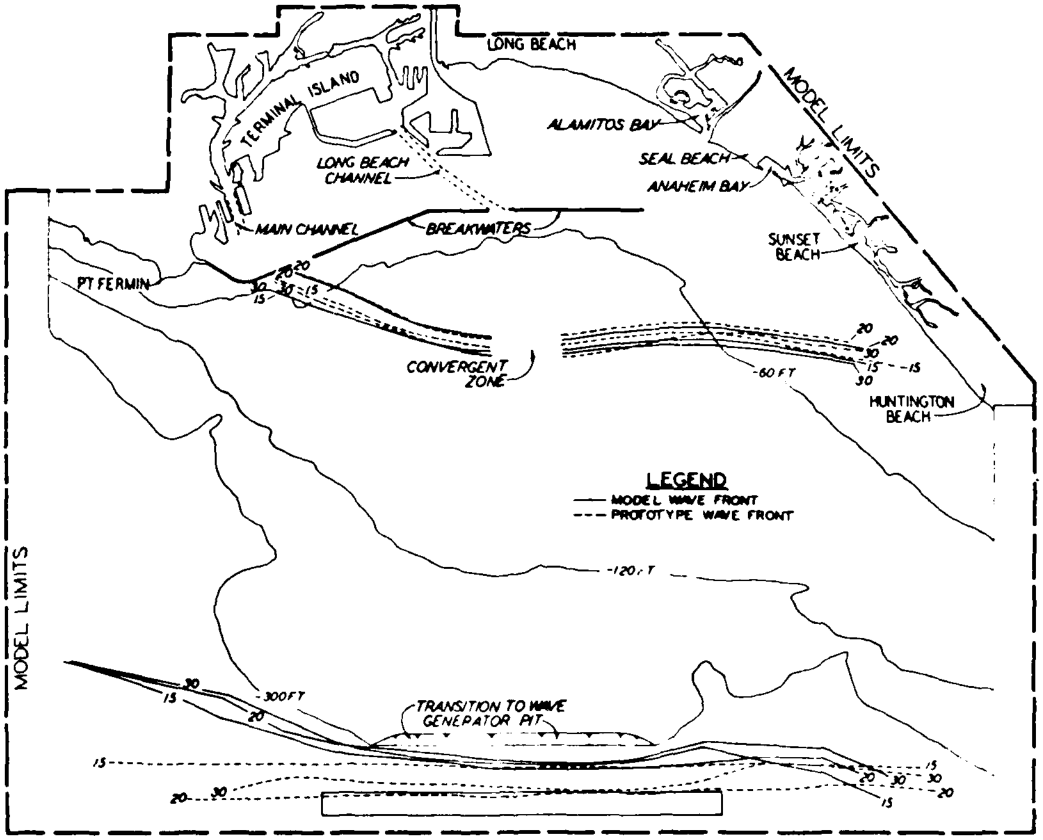

Figure 6. Comparison of model and prototype wave fronts near the -300 ft mllw contour and near the harbor at 15, 20, and 30 sec

prototype wave periods of 15, 20, and 30 sec. The initial prototype and adjusted model wave-front locations are shown along with a comparison of wave-front locations for each of the wave periods seaward of the harbor breakwater after formation of the convergent zone. A 15-ft unit of the wave generator with the frame, wave paddle, and hydraulic power supply is shown in Figure 7. Each unit is independently controlled from a computer-generated command signal. Performance tests indicate that each unit will consistently maintain a peak-to-peak stroke error of less than 1 percent and that the maximum phase lag variation between any 2 of the 14 units from the command signal is 4 deg or less. Variation in the generated period is negligible for each unit. The detailed

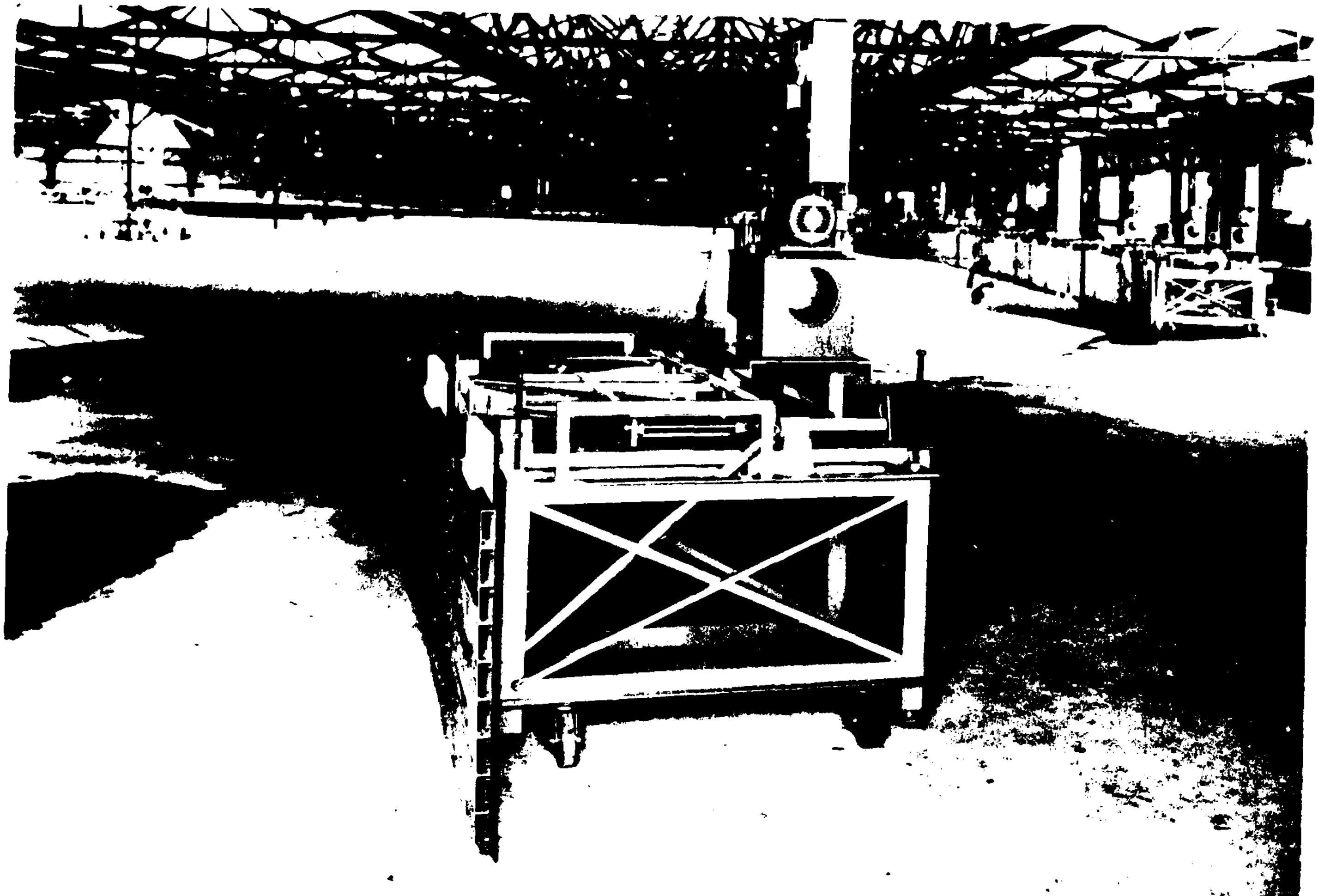

Figure 7. Electrohydraulic wave generator unit with frame, wave paddle, and hydraulic power supply

design and operation of the wave generator is discussed in Reference 5.

Wave data acquisition

14. Wave data acquisition in the Los Angeles and Long Beach Harbors model is controlled[5] by an automated data acquisition and control system (ADACS) due to the complexity, large size, and magnitude of model wave data required. The ADACS configuration consists of four subsystems: (a) digital data recording and controls, (b) analog recorders and channel selection circuits, (c) wave and interfacing equipment, and (d) wave generators and control equipment.

15. The digital data recording and control subsystem is built around a 32K minicomputer with 16-bit words of core memory and a 1-μsec cycle time. Peripheral devices include a 1.1 million word moving head disc and a magnetic tape controller with two 9-track tape units for data and software storage. A teletype unit serves as the master console and a matrix electrostatic printer/plotter is used for output. Data acquisition is automatic without operator intervention once a wave test begins. The analog recording subsystem consists of five 12-channel oscillographs and provides a visual record of the analog wave-gage signal.

16. The wave gages are parallel wire, water-surface-piercing, resistance gages as shown in Figure 8. The gage measures the conductance of water between two vertical parallel wires. The conductance is directly proportional to the depth of submergence of the parallel wires. The gages can accurately detect changes in model water-surface elevation of 0.001 ft (prototype 0.10 ft).

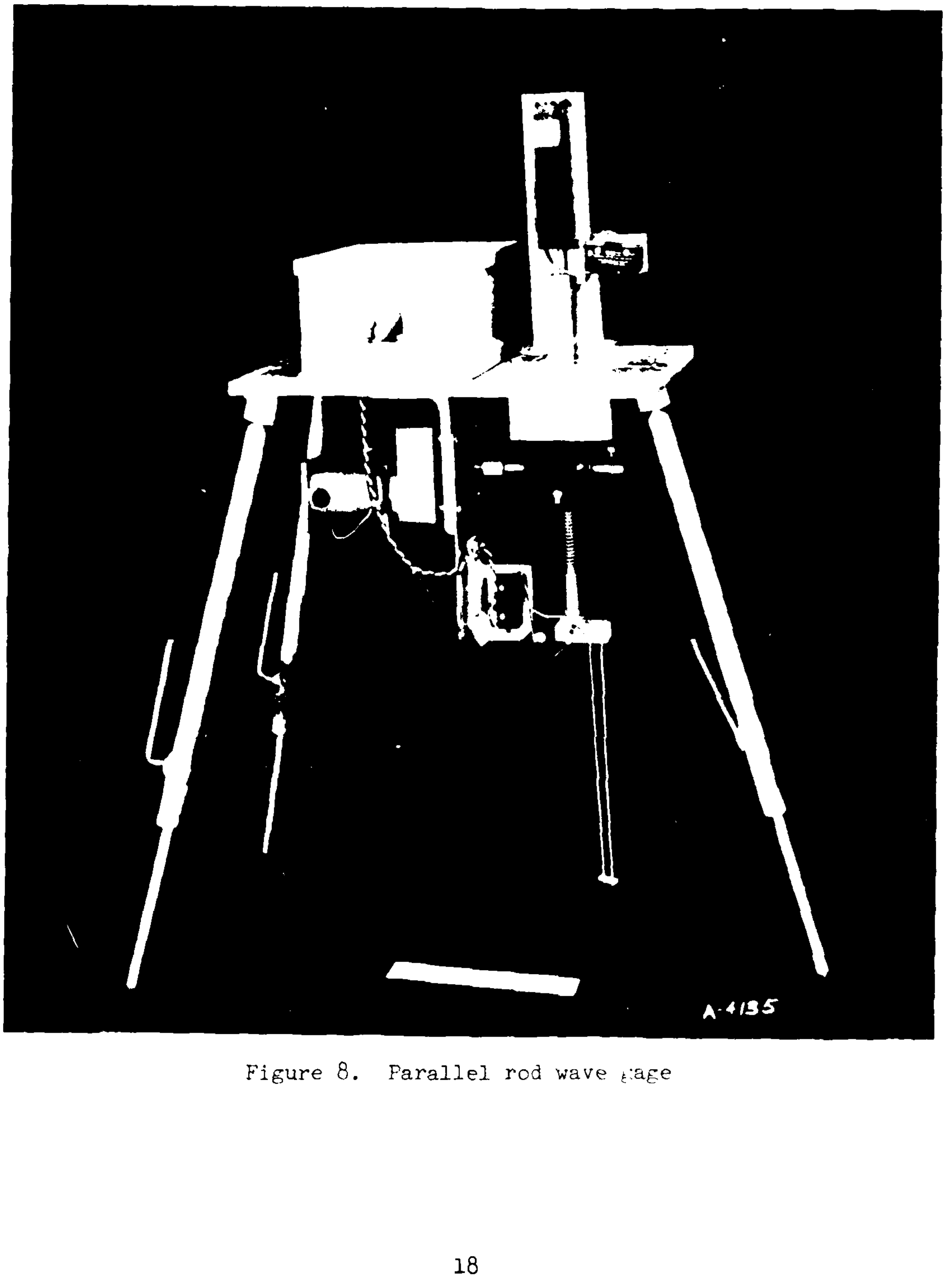

Figure 8. Parallel rod wave gage

PART III: DATA ANALYSIS

Test Conditions

17. Tests were conducted for long-period waves approaching the continental shelf seaward of the harbor from the relatively narrow long-period energy window[1,5] centered around the south direction. Figure 9 illustrates the wave generator position computed in Reference 5 for various period ranges. Normalized wave-height variations along the wave front were simulated in accordance with the model design refraction data. A maximum prototype wave height of 4 ft at the generated wave front was used in the 15.4- to 150.0-sec prototype period range. Between 150 sec and 280 sec, a 3-ft maximum prototype wave height was used, while above 280 sec a 2-ft maximum wave height was used. The variation in wave height over these period ranges was necessary to decrease the magnitude of strong resonant oscillations and minimize finite amplitude effects on wave characteristics while maintaining sufficiently large model waves to obtain accurate model measurements throughout the area of interest. The still-water level during the test series was +2.8 ft mllw and the wave period interval between tests varied from 0.5 sec to 5.0 sec (prototype). Smaller period increments between wave tests were used in the lower period range to ensure accurate definition of sharp resonant peaks.

Wave-Height Amplification

18. The significant wave height (H_s) at each gage location was calculated from the digital wave record (24 to 60 recorded cycles) and corrected for model scale effects due to internal and bottom friction during propagation from the wave generator to the harbor. A detailed discussion of the relatively small correction for viscous attenuation is given in Reference 5.

19. Wave-height amplification is traditionally defined as the ratio of the wave height at a particular location in a harbor to twice

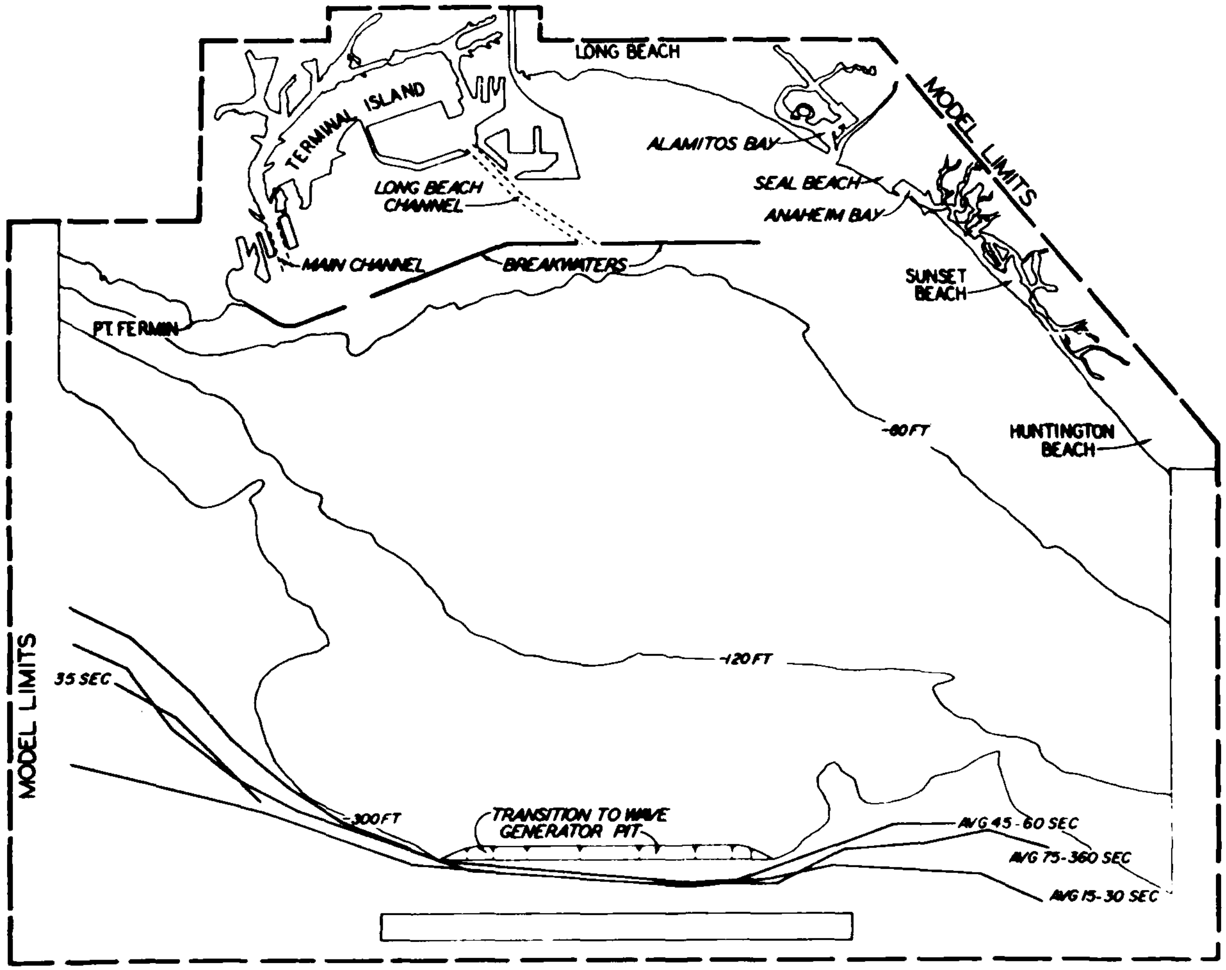

Figure 9. Mean wave generator positions

the incident wave height at the harbor mouth. This definition results from the fact that the standing wave height for a straight coast with no harbor would be twice the incident wave height due to superposition of the incident and reflected waves. In the hydraulic model, the wave heights also are affected by refraction and are variable along the outer harbor breakwater, are significantly different at Queen's Gate and Angel's Gate, and are even variable along the model wave generator. Consequently, another definition of amplification is necessary. A consistent definition can be based on the incident wave height in deep water seaward of the model wave generator location. Therefore wave-height amplification (R) for the model was calculated as the ratio of the significant wave height at each gage location to the incident wave height H_i which would have occurred at the initial wave-front position (approximately 38 miles seaward of the breakwater) used in the model design wave refraction analysis, or

$$R = \frac{H_s}{H_i} \tag{3}$$

The initial wave-front position for the refraction analysis is shown in Figure 5 for a 60-sec wave period. Average depth along the initial wave front is approximately 3470 ft. The model wave height H_m at each gage location was corrected for shoaling differences due to model distortion when calculating prototype wave heights or;

$$H_s = H_r \frac{K_s^{P,G}}{K_s^{M,G}} H_m \tag{4}$$

where

H_r = the vertical scale ratio

$K_s^{P,G}$ = the prototype shoaling coefficient

$K_s^{M,G}$ = the model shoaling coefficient at the gage locations

Similarly, the prototype generated wave height H_w^P is

$$H_w^P = K_r \frac{K_s^{P,W}}{K_s^{M,W}} H_w^M \tag{5}$$

where

K_r = the refraction coefficient

$K_s^{P,W}$ = the prototype shoaling coefficient evaluated at the wave generator position

$K_s^{M,W}$ = the model shoaling coefficient evaluated at the wave generator position

H_w^M = the model generated wave height

The prototype wave height at the wave generator may also be written in terms of H_i as

$$H_w^P = K_r \frac{K_s^{P,W}}{K_s^{P,A}} H_i \tag{6}$$

where $K_s^{P,A}$ is the shoaling coefficient at the initial refracted wave-front position for the 3470-ft average depth. Substituting from Equations 2, 3, and 4, the wave-height amplification may be written in terms of model wave heights as

$$R = K_r \frac{K_s^{P,G} K_s^{M,W}}{K_s^{P,A} H_w^M K_s} H_m \tag{7}$$

The refraction coefficient is available from the model design refraction analysis, and the shoaling coefficients are a function of wavelength and water depth.

PART IV: HARBOR OSCILLATION RESULTS

Test Results

20. Wave tests were conducted for existing conditions (base plan) and for the Modified Phase I plan. Wave gage locations in the existing harbor and the Modified Phase I plan are shown in Plates 1 and 2. Due to the placement of gages in and near areas of proposed harbor improvement, wave gages at the same locations in the existing harbor area usually will not have the same number for both plans. Table 1 lists the gage numbers and corresponding locations of gages used in the Base Plan and Modified Phase I plan including the 36 corresponding gages for both plans. Wave-height amplification data at each gage location for existing conditions are shown in Plates 3-51. Amplification data for the Modified Phase I plan gages listed in Table 1 also are plotted for comparison with existing conditions on the corresponding plates. On the plates which show comparison plots, the time scale changes at 120 sec in order to provide a readable comparison of the amplification data in the shorter period range. Wave-height amplification data for the remaining Modified Phase I plan gage locations in and near the proposed improvements are presented in Plates 52-64. Contour plots of the modes of oscillation for resonant periods are presented in Plates 65-91. The contour plots of wave-height amplification show the nodes and antinodes of the resonant oscillation. Maximum currents and the maximum horizontal water displacement will occur near the nodal area of the oscillation. Maximum vertical movement of the water will occur at the antinodes of the oscillation. Location of nodes, antinodes, and water particle motions for an idealized rectangular channel with a node at the channel entrance are shown in Figure 10.

Existing Harbor

East Channel

21. Model wave-height amplification data for gage 6, Plate 8,

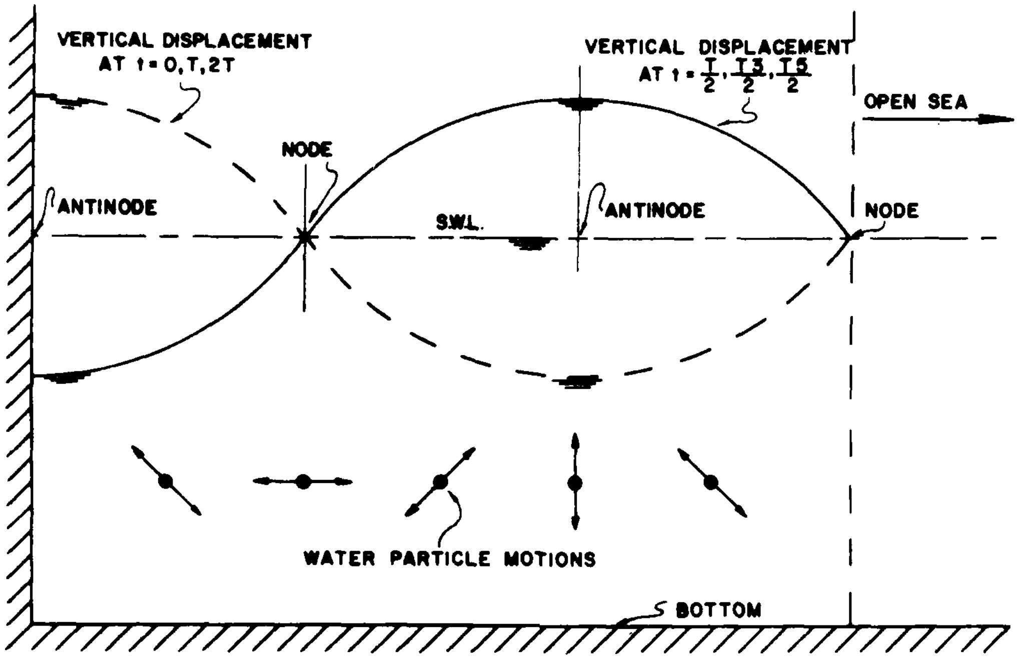

Figure 10. Node, antinode, and water particle motions in a rectangular channel open to the sea with a node at the channel entrance

indicated maximum amplification occurred for the fundamental mode of oscillation at 385 sec for existing conditions and at 370 sec for the improvement plan. The second largest amplification for existing conditions developed at 96 sec. A similar oscillation developed for the improvement plan at 95 sec but with amplification approximately 14 percent lower. The resonant peak with the third largest amplification was at 285 sec for existing conditions and 265 sec for the improvement plan. Maximum amplification for this mode increased approximately 10 percent for the improvement plan.

22. For existing conditions, the modes of oscillation of the 96-sec, 285-sec, and 385-sec oscillations in East Channel are shown in Plates 65-67. Corresponding modes of oscillation for the Modified Phase I plan are shown in Plates 76, 77, and 78. As shown in Plate 67, the fundamental mode of oscillation at 385 sec has a nodal area outside the channel near the tip of berth 50 at the Bulk Loading Facility. The

370-sec oscillation mode is similar, but with the nodal area closer to the channel entrance as expected for a shorter wave period and corresponding shorter wavelength. Higher currents associated with the nodal area occur near berth 50 for each of the oscillations. The 280-sec mode of oscillation also is a fundamental mode of oscillation but with the nodal area located just inside the channel entrance and with an antinode near berth 50. The development of two modes of oscillation, each of which appears to be a fundamental mode for East Channel, is probably due to the submerged bar along the east side of East Channel at a depth of 20 ft mllw relative to a dredged depth of approximately 50 ft mllw in the channel. This submerged bar has the effect of increasing the length of the channel along the east side opposite berth 50. At 96 sec, a nodal area is located at approximately one-third the length of the channel from the north end and at the channel entrance. The 96-sec oscillation, second harmonic of the 280-sec oscillation, has potential for a more severe impact on ship mooring conditions due to the higher currents in the nodal areas and the tendency of general cargo ships to respond over a period range including 96 sec. The 95-sec oscillation, for the improvement plan shown in Plate 76, was similar but with lower amplification.

23. Estimates[4] of spectral energy density from the WES prototype wave gage data from the same location as model gage 6 for 10 time periods during which concurrences of medium/heavy ship motion were reported in East Channel indicated that the maximum wave energy occurred in the channel near 387.5 sec with a smaller peak near 267.5 sec. These two resonant periods correlate well with the fundamental modes found in the model study (385 sec and 285 sec). The 96-sec oscillation is apparent in the prototype data but is not as well defined. The estimates of spectral energy density are dependent on the distribution of incident wave energy over the frequency range and the relative magnitudes of peaks in the energy spectrum will be affected by the incident energy level. Analysis of the prototype data is discussed extensively in Reference 4 and results of the analysis are given. Typical spectral energy density results from the analysis in Reference 4 for the north end

of East Channel are shown in Figure 11. The results present the maximum, minimum, and average spectra for 14 overlapping time periods starting on 16 October 1971.

West Channel

24. Wave-height amplification data for existing conditions at the rear of West Channel, shown in Plate 7, indicated a maximum amplification of 4.0 at 209 sec with two small resonant peaks at 67 sec and 91 sec, with amplification values of 1.3 and 1.1, respectively. Maximum amplification for the proposed plan was approximately 33 percent lower and at a period of 218 sec. Resonant oscillations again occurred near 67 sec and 91 sec with amplification similar to that for existing conditions. For each plan, amplification was increasing at the 410-sec limit of the period range tested.

Los Angeles Main
Channel and Inner Harbor

25. Wave-height amplification for existing conditions in the Los Angeles Main Channel and Inner Harbor was low in the period range included in the study, except at the Main Channel entrance and near the upper limit of the period range. Amplification data for gage 11, located in the center of the channel entrance, indicated resonant peaks of 1.7, 1.6, 1.4, and 1.8 at 108, 167, 218, and 270 sec, respectively. Resonant peaks at the four periods were evident in the amplification data for the Inner Harbor, particularly at gages 16 and 17, but with a lower peak amplification. In general, the Los Angeles Inner Harbor area had relatively low amplification of the incident wave energy except as indicated near the upper limit of the test series. The lack of development of any strong resonant peaks in the Inner Harbor, such as occurred in East Channel, does not mean that long-period wave energy did not penetrate into the Inner Harbor, but that the Inner Harbor did not respond to the long-period wave energy over the period range tested.

26. Maximum amplification in the Inner Harbor for the improvement plan was relatively low and similar to that for existing conditions except near the upper limit of the period range tested. The resonant oscillation indicated for existing conditions near 410 sec peaked for

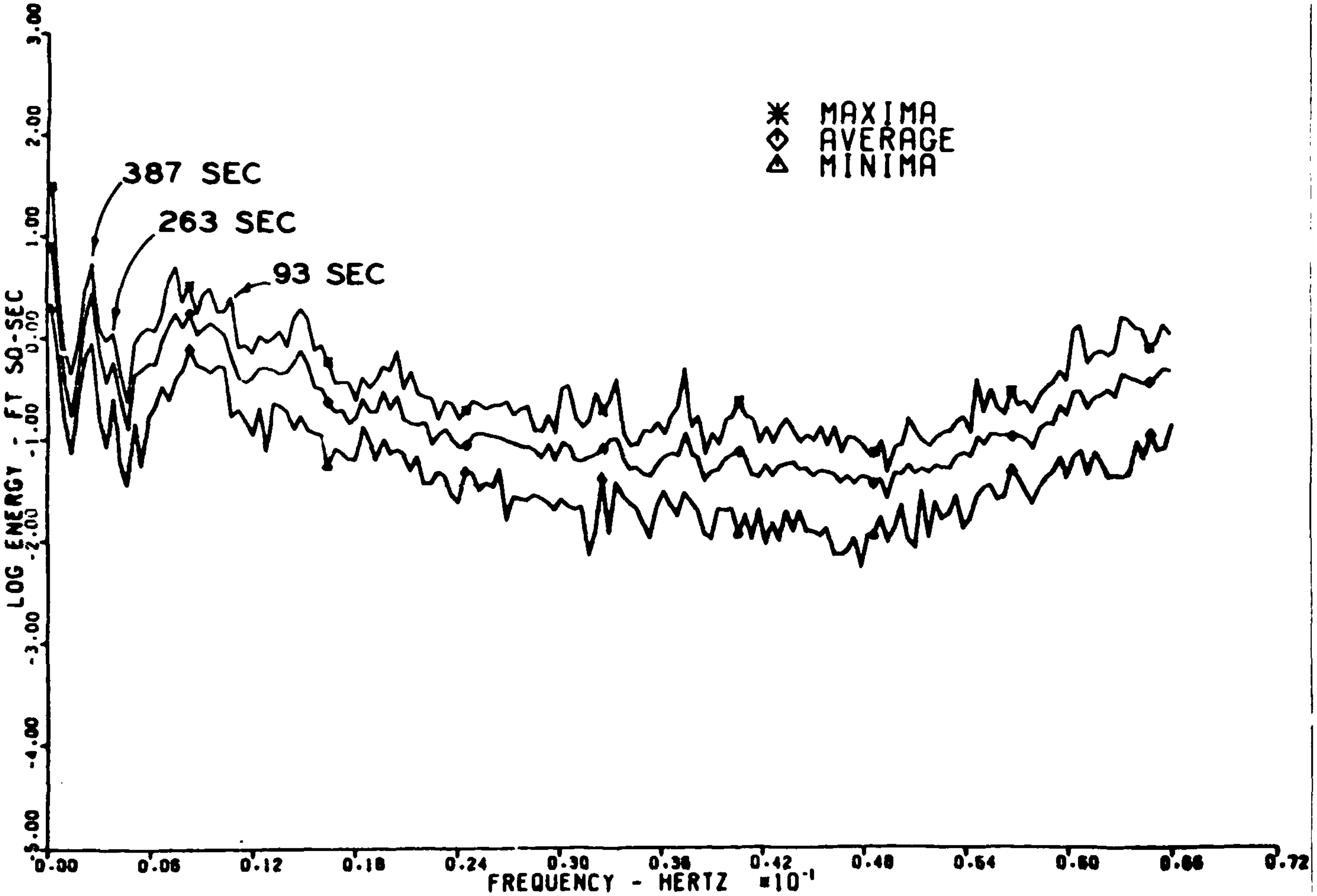

Figure 11. Typical spectral energy density results for the East Channel

the improvement plan at 390 sec with a maximum amplification indicated by gages 16 and 17 of approximately 3.0. At the Main Channel entrance, the peak amplification at 270 sec for existing conditions shifted to 265 sec for the improvement plan and increased approximately 40 percent to 2.5. Contour plots of wave-height amplification are not presented due to the relatively low amplification at periods less than approximately 400 sec in the Inner Harbor.

27. A prototype wave gage corresponding to gage 20 (model) was located in the West Basin of the Inner Harbor. The prototype wave data analysis indicated long-period wave energy was low in West Basin over the 15- to 410-sec period range but that peaks in the energy spectrum did occur near 263, 87, and 61 sec. Although low in absolute amplification, resonant peaks also occurred in the model at 255, 85, and 60 sec. Typical overlapping spectral energy density results in West Basin for the 16 October 1971 time period (paragraph 23) are shown in Figure 12.

Southeast Basin

28. In Southeast Basin of Long Beach Harbor, the modes of oscillation are affected by the complex geometry of the basin and resonant modes developed in various sections of the basin which did not extend throughout the entire basin. In the existing harbor, resonant peaks developed at 79, 86, 93, 97, 162, and 226 sec as indicated by the amplification data for gages 26-34 (Plates 28-36). The modes of oscillation for each period and the sections of the basin affected by each oscillation are shown in Plates 68-73. The oscillation with the maximum amplification, 226 sec, occurred primarily in Slip 7 with a smaller antinode in the corner between berths 236 and 242. Slip 7 is relatively unaffected by the remaining oscillations. At 162 sec, the oscillation developed in the outer area of the basin with antinodes near the entrance to the basin and at berth 242, and with a node near berth 246. The oscillations at 79, 86, 93, and 97 sec developed in Pasin 6 but only the 79- and 97-sec oscillations extended into the outer basin area.

29. Resonant oscillations with the Modified Phase I plan developed at similar periods of 243, 153, 88, and 78 sec (also shown in Plates 28-36). The amplification for oscillations at 57 and 63 sec, relatively

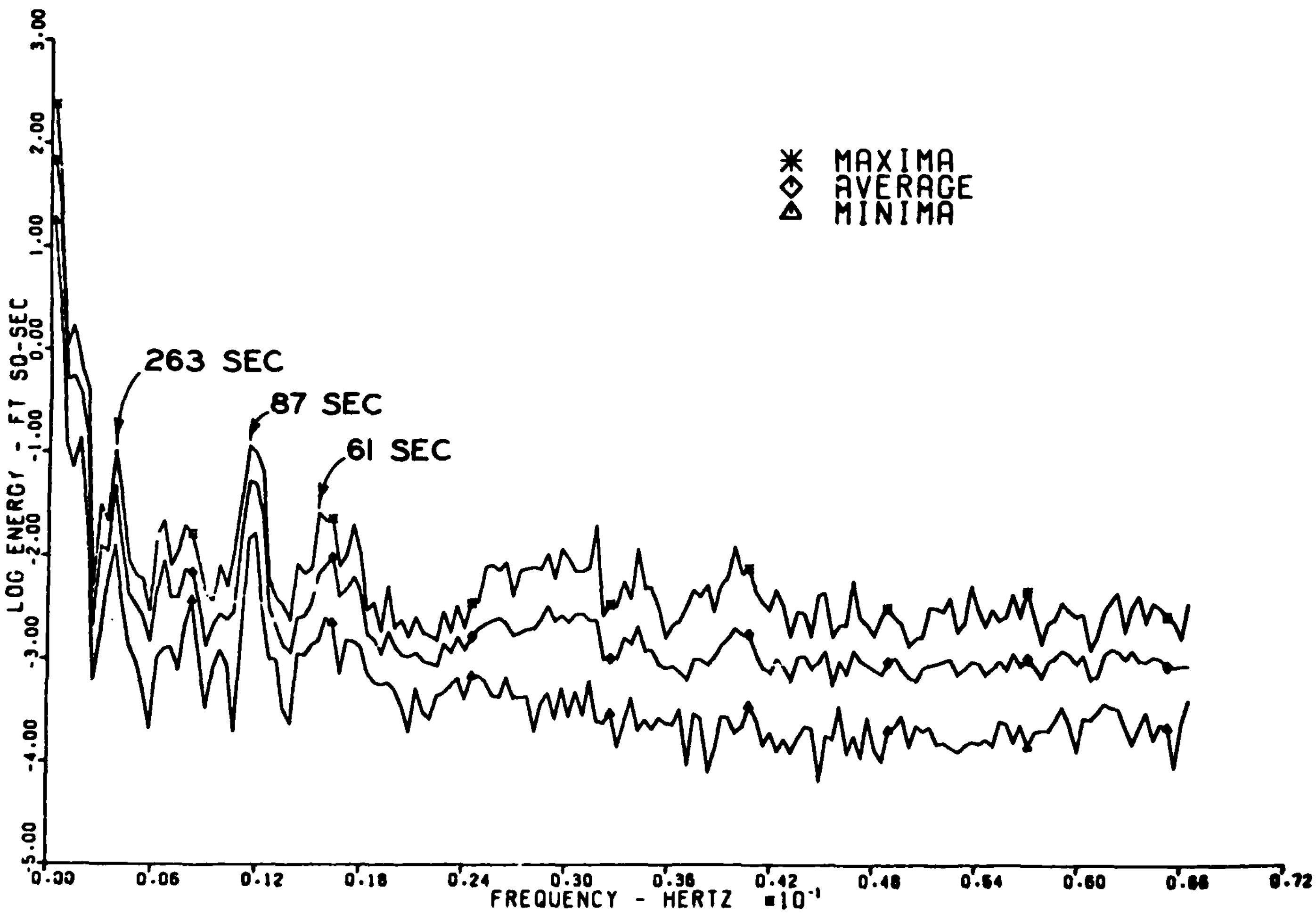

Figure 12. Typical spectral energy density results for West Basin

low for existing conditions, increased substantially to 2.4 and 2.9 and primarily occurred in the outer basin area and Slip 7. Modes of oscillation for all six periods are shown in Plates 79-84. At the corner between berths 244 and 245 (troublesome mooring conditions are occasionally experienced at berths 245, 246, and 247) amplification data for gage 27 indicated that the 153-sec oscillation increased for the improvement plan but remained lower than the maximum amplification at 226 sec for existing conditions. The resonant amplification at 42 sec and 57 sec also increased but remained lower and occurred over a narrower period range than the resonant peak at 79 sec for existing conditions. A resonant peak did occur at 79 sec for the improvement plan but decreased approximately one-third in amplitude.

30. The maximum amplification in Slip 7 (gage 29) for the improvement plan decreased 64 percent (from 9.2 to 3.3) and the period shifted from 226 sec to 243 sec. The second largest peak for the improvement plan occurred at 63 sec with an amplification of 2.9, an increase of 21 percent over the peak for existing conditions at 61 sec. A relatively low amplification peak also developed at 42 sec for the improvement plan.

31. The only resonant mode in Basin 6 for which amplification for the improvement plan increased significantly was at 88 sec. This mode had a maximum amplification of 3.7 at berth 211-A. However, the three amplification peaks with magnitude near 2.0, which developed for existing conditions at 86, 93, and 97 sec, were replaced by the 88-sec oscillation. At berth 208 in Basin 6, the strong resonant peak at 79 sec was shifted to 78 sec and reduced 31 percent by the improvement plan.

32. Berth 208 (gage 33) also can be significantly affected by wave energy in the swell range near 16 sec and a comparison of wave-height amplification for 15.6 to 17.2 sec is given in Figure 13. With the improvement plan, maximum amplification is decreased by 13 percent. As indicated by Figure 13, the maximum amplification at 16.2 sec is quite low, but the incident significant wave height[6] in the 16- to 18-sec range can approach 8 to 10 ft at the Middle breakwater and Queen's Gate, resulting in reasonably large wave heights at berth 208.

33. In the WES prototype data acquisition program, prototype gages

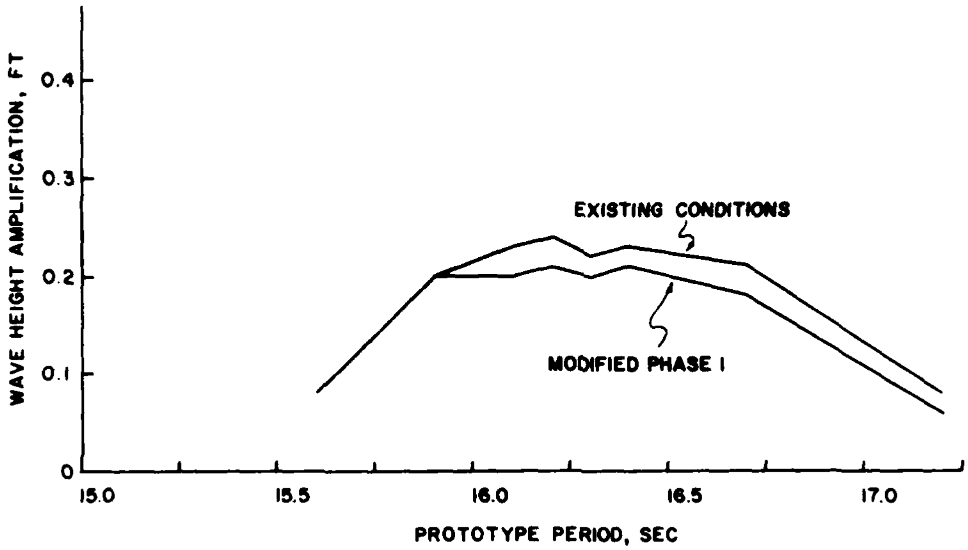

Figure 13. Comparison of wave-height amplification for existing conditions and the Modified Phase I plan at berth 208 in the swell range

were at identical locations as model gages 29 and 33. The distinct resonant peaks at 61 and 226 sec in the model wave-height amplification data for Slip 7 (gage 29) correspond closely with estimates of increased spectral energy density from the prototype near 62 and 217.5 sec. At berth 208 (gage 33), the resonant peaks at 79 and 86 sec correspond closely with estimates of spectral energy density from the prototype wave data near 81 and 87 sec. Typical overlapping spectral energy density results for the 16 October 1971 time period (paragraph 23) are shown in Figures 14 and 15 for Slip 7 and Basin 6, respectively. The peak at 93 sec for Slip 7 results from an increased incident wave energy level at 93 sec in comparison with the energy near 63 sec.

East Basin and Back Channel

34. Maximum amplification observed during the study for existing conditions occurred in Slip 3 of East Basin in the Port of Long Beach (gage 42). The response for gage 42, shown in Plate 44, is generally low except near 224 sec where a maximum amplification peak of 10.2 occurred. The mode of oscillation is shown in Plate 74 and is the fundamental mode with a nodal area just outside the slip entrance. The lack

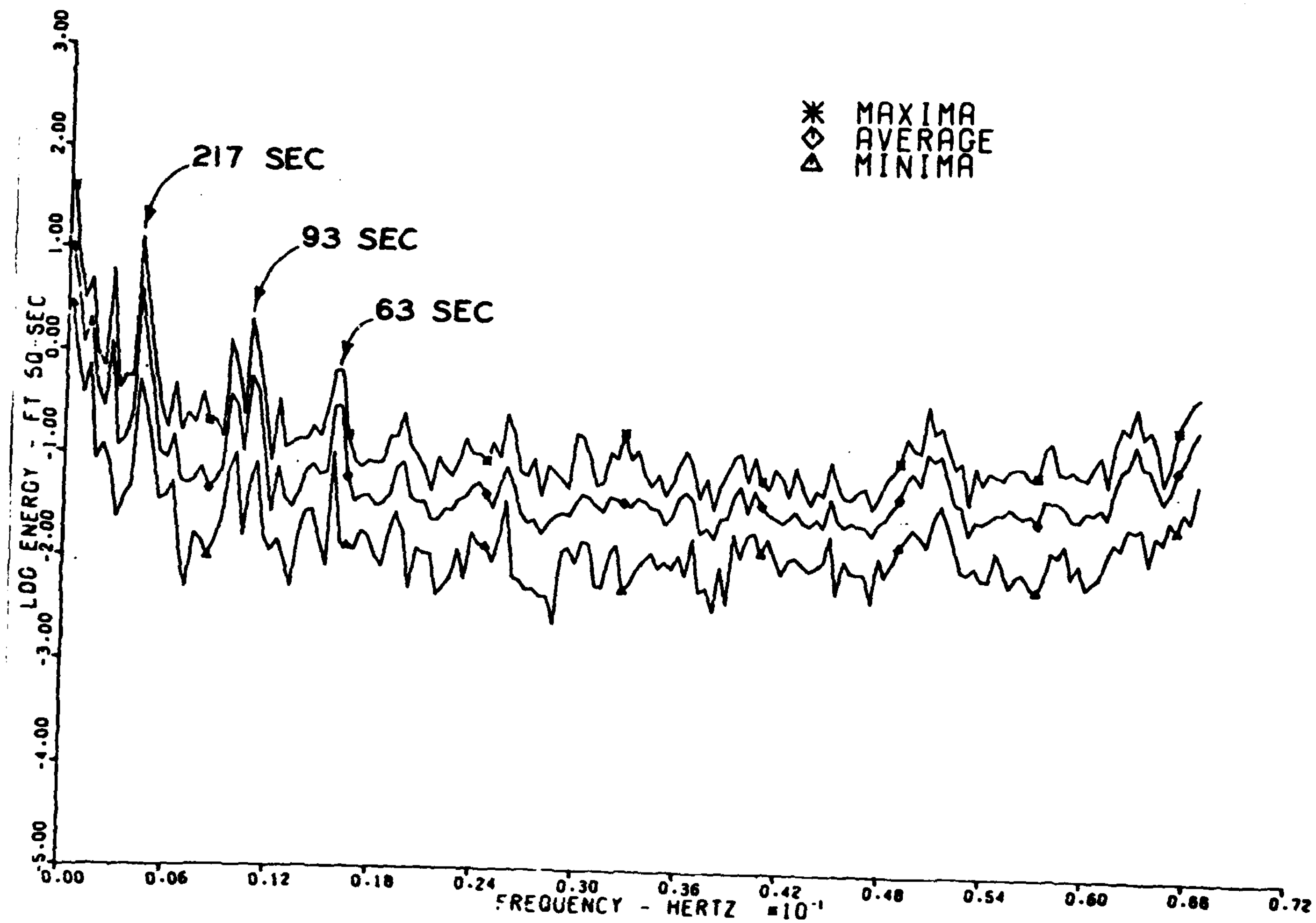

Figure 14. Typical spectral energy density results for Slip 7

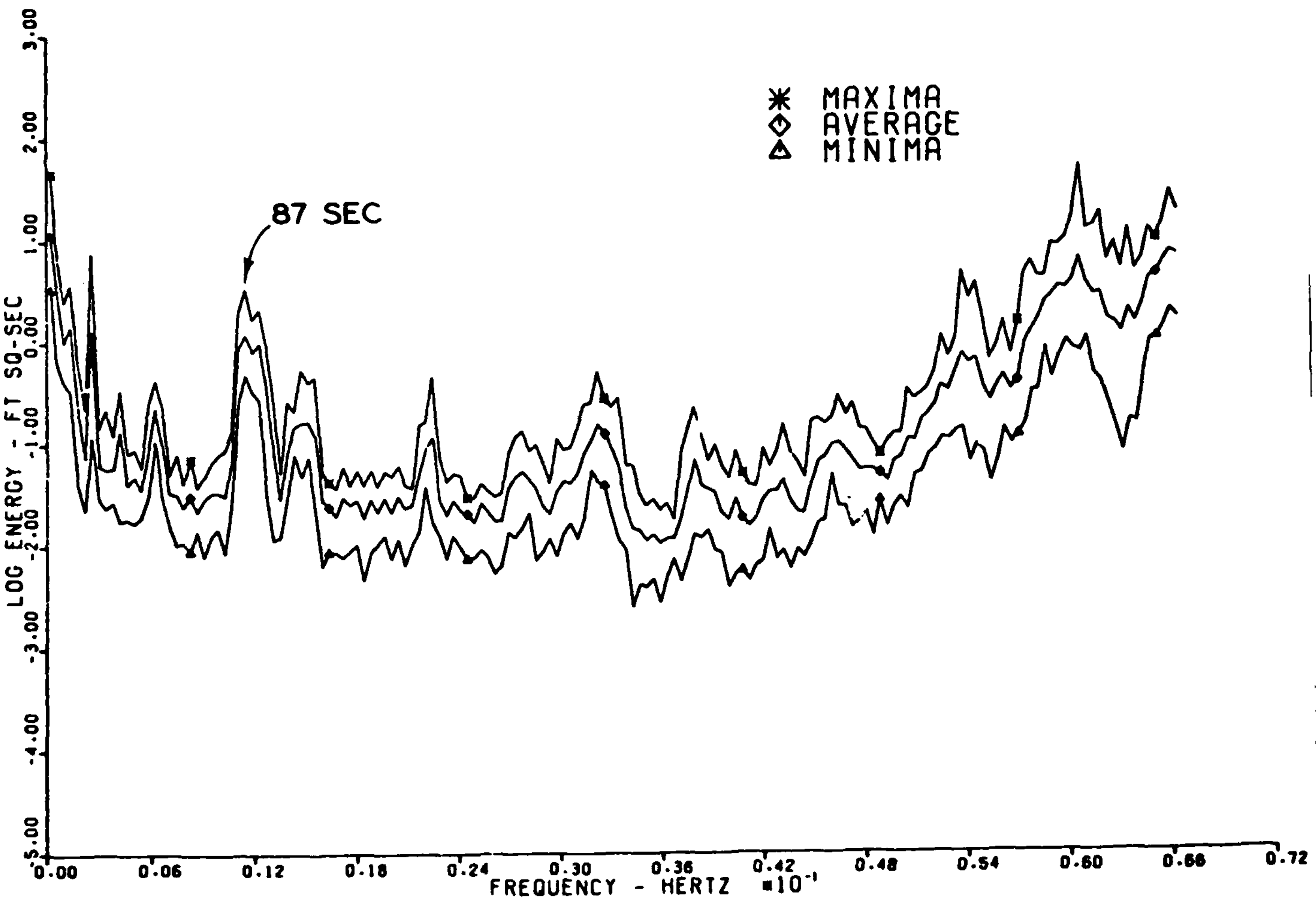

Figure 15. Typical spectral energy density results for Basin 6

of reported troublesome mooring conditions in the slip indicates that the oscillation has little effect on ship mooring, probably due to the location of the nodal area and the relatively long period of the oscillation. The 224-sec oscillation is also the fundamental mode of oscillation for Slip 2 but has a maximum amplification of only 3.7. The 224-sec oscillation also extends into the Back Channel with an antinode near berths 118 and 119 (the Atlantic-Richfield Oil Terminal).

35. Maximum response in Back Channel occurred at 204 sec, not 224 sec as in Slip 3, with an amplification of 4.3. The mode of oscillation for the 204 sec peak is shown in Plate 75. The antinode of the oscillation again occurred near berths 118 and 119.

36. Resonant response in East Basin and Back Channel for the proposed improvements was similar, but with amplification of the fundamental mode of oscillation for Slip 3 decreased to 7.7 (from 10.2) and shifted to 218 sec. The period of maximum response for Back Channel (gage 40) shifted to 203 sec from 204 sec (essentially the same as that for existing conditions) with little change in amplification. The mode of oscillation for the 218- and 203-sec resonant peaks are shown in Plates 85 and 86.

Proposed Improvements

Seaplane anchorage

37. As indicated by the amplification data from gage 15 near the seaplane anchorage (Figure 2), a number of resonant peaks between 60 and 300 sec (with an amplification near 4.0) occurred for existing conditions. With installation of the proposed improvement plan, amplification below 90 sec of resonant peaks generally increased slightly with small shifts in period. Resonant peaks in the seaplane anchorage above 90 sec increased approximately 50 percent near 108, 155, and 278 sec, again with small shifts in periods.

Outer Harbor Oil Terminal

38. Resonant peaks developed at periods of 96, 111, 169, 183, and 295 sec (Plates 57-63) in the oil terminal. Modes of oscillation for

the resonant periods are shown in Plates 87-91. The 295-sec oscillation is present on all gages in the oil terminal and had an antinode in the center of the terminal with nodes well outside the terminal. The 169- and 183-sec oscillations were similar and had antinodes near the center of the oil terminal but with nodal areas closer to the east and west ends of the terminal than the 295-sec oscillation. The 169- and 183-sec oscillations also did not extend over as broad a period range as the 295-sec oscillation and were approximately 40 percent lower in maximum response.

39. The 111-sec oscillation developed primarily on the north side of the center dike and had relatively low amplification in the area of the dredged channel and the oil terminal berths. As shown in Plate 88, the oscillation north of the center dike appears to be a fundamental mode between the dike and the south face of Pier J, but a fundamental mode of this type would have a period near 60 sec, not 111 sec. Analysis of the amplification data for the oscillation indicated that a dual mode of oscillation had developed with the antinodes near each end of the center dike 180 deg out of phase. The corresponding antinodes along Pier J were also 180 deg out of phase. For the cross-channel oscillation, the antinodes of the oscillation adjacent to the center dike occurred with a phase lag of approximately 20 deg from the corresponding antinode adjacent to Pier J. The water particle displacement in the nodal area of the oscillation will tend to occur in a loop pattern rather than in the back-and-forth motion indicated in Figure 10.

40. At 96 sec, an oscillation developed with a node near the two eastern oil terminal berths. This mode of oscillation, shown in Plate 87, has the potential of creating troublesome ship motion in the surge component if a resonant frequency of the ship and mooring system is near 96 sec.

Summary

41. Periods and amplitudes of maximum resonant response for various berthing areas in Los Angeles and Long Beach Harbors were:

Location	Existing Conditions Period sec	Existing Conditions Amplification	Modified Phase I Period sec	Modified Phase I Amplification
Los Angeles Harbor				
West Channel	209	4.0	218	3.7
East Channel	96	4.1	95	3.5
	280	3.7	265	4.1
	385	11.0	370	12.0
Long Beach Harbor				
Southeast Basin	79	4.9	57	2.7
	86	2.2	63	2.9
	93	1.8	78	3.5
	97	2.1	88	3.7
	162	2.9	153	4.2
	226	9.2	243	3.3
East Basin	224	10.2	218	7.7
Back Channel	204	4.3	203	4.1
Outer Harbor Oil Terminal	Not Applicable		96	4.0
			111	4.1
			169	4.3
			183	4.0
			295	7.1

As indicated by the preceding tabulation, resonant oscillations generally developed at similar periods for existing conditions and the Modified Phase I plan. Several exceptions occur in Southeast Basin.

42. In the Outer Harbor Oil Terminal, nodal areas for the 169-, 183-, and 295-sec resonant peaks occurred outside the limits of the berthing area while the 96- and 111-sec resonant peaks possessed nodal areas near berthing areas.

PART V: CONCLUSIONS AND RECOMMENDATIONS

Conclusions

43. Wave-height amplification in the Los Angeles and Long Beach Harbors was not substantially altered by the Modified Phase I plan. Major resonant peaks in existing berthing areas which increased significantly (greater than 20 percent in magnitude) were in the shorter period range (less than 100 sec with the exception of the 153-sec peak in Southeast Basin) and occurred over a narrow period band. Only a small amount of energy in the incoming wave spectrum would be contained over the narrow period range of these sharp, narrow peaks; consequently, they should have a relatively small effect on ship response. In the longer period range above 200 sec, the broad resonant peaks in East Channel, Southeast Basin, and East Basin have increased slightly in amplification or have decreased. Specific conclusions resulting from the comparison of wave data for existing conditions and for the Modified Phase I plan are:

- a. Resonant periods in the model and prototype are in agreement for existing conditions.
- b. Wave-height amplification in existing berthing areas has generally not changed significantly or has decreased.
- c. In East Channel, wave-height amplification is similar for the Modified Phase I plan below 200 sec with a 15 percent decrease in maximum amplification near 96 sec.
- d. In Southeast Basin, resonant amplification at several periods increased but remained lower than the resonant amplification for existing conditions at nearby periods.
- e. Ship mooring conditions should not be adversely affected in the existing harbor by the Modified Phase I plan with the possible exception of (1) Southeast Basin where the response of moored ships to shorter periods (40- to 60-sec range) could increase and (2) East Channel where the resonant response of the channel at the two longer period modes of oscillation increased by 10 percent.
- f. Of the six resonant modes of oscillation which developed in the proposed Long Beach Outer Harbor Oil Terminal, only one mode (96 sec) had a node located near an oil terminal berth. Amplification at 96 sec is relatively low and mooring conditions may be satisfactory provided the moored ship does not respond significantly to a period near 96 sec.

44. Wave-height amplification and resonant modes of oscillation for existing conditions and the Modified Phase I plan have been determined in the hydraulic model study. Moored ship response is a function of incident wave amplitude, frequency of incident wave spectrum, response of the harbor to wave excitation, types of mooring lines and configurations used, and characteristics of the ship period. Results from the model study may be used in a comprehensive numerical or experimental investigation of moored ship response to quantify the extent of potential moored ship motion for all 6 deg of freedom for either existing conditions or proposed improvement plans within the Los Angeles and Long Beach Harbors complex.

Recommendations

45. It is strongly recommended that either a numerical or experimental moored ship response study be undertaken to adequately quantify moored ship response in Los Angeles and Long Beach Harbors. The effect of increased wave-height amplification or a shift in the period of maximum amplification cannot be readily evaluated until the response function of the ship is known. Without ship response data, the effect of changes in resonant oscillations in the harbor must be inferred from comparison with existing conditions and from comparison between various berthing areas in the harbor for existing conditions.

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2. Pickett, E. B., Durham, D. L., and McAnally, W. H., Jr., "Los Angeles and Long Beach Harbors Model Study; Prototype Data Acquisition and Observations," Technical Report H-75-4, Report 1, Jun 1975, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.
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6. Hales, L. Z., "Transmission of Wave Energy Through and Overtopping of the Long Beach, California, Breakwater; Hydraulic Model Investigation," Miscellaneous Paper H-76-10, May 1976, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.

Table 1

Corresponding Wave Gage Numbers and

Locations for Base Plan and the Modified Phase I Plan

Base Plan	Modified Phase I Plan	Location
1	1	Angel's Gate - Center
2	2	Outside Angel's Gate - West
3	3	Inside Angel's Gate - West
4	4	Bulk Terminal - Berth 47
5	5	West Channel - North End
6	6	East Channel - North End
7	7	East Channel - Midpoint
8	8	East Channel - Entrance
9	9	East Channel - Berth 51
10	--	East Channel - Berth 50
11	10	Main Channel - Entrance
12	11	Main Channel - South of Reservation Point
13	--	4000 ft South of the Seaplane Basin Entrance
14	--	SW Corner Reeves Field - Waterside
15	17	NE Corner Seaplane Basin
16	19	Main Channel (East Side) Berth 229
17	18	Main Channel (West Side) Berth 89
18	--	Inner Harbor - Berth 109
19	--	Turning Basin - Berth 151
20	20	West Basin - North End
21	21	East Basin - East Side
22	22	Queens Gate - Center
23	23	Outside Queen's Gate - West
24	24	Inside Queen's Gate - West

(Continued)

Note: Gages 18 and 19 for the Modified Plan are reversed from the order shown in the Draft Report. This is based on locations shown in Plates 1 and 2.

Table 1 (Continued)

Base Plan	Modified Phase I Plan	Location
25	--	1000 ft South of Pier J - Center
26	32	Pier J - Berth 247
27	33	Pier J - Berth 245
28	34	Pier J - Berth 242
29	35	Slip 7 - North End (Berth 231)
30	36	Slip 7 - Midpoint
31	37	Pier G - South End
32	39	Basin 6 - Berth 211A
33	38	Basin 6 - Berth 208
34	40	Pier F - Berth 204
35	--	Navy Mole - South Center
36	--	Navy Mole - SW Diagonal
37	41	Navy - West Basin - NW Corner
38	--	Pier E - Berth 122
39	--	Pier E - Berth 120
40	45	Pier E - Berth 119
41	--	Pier E - Berth 118
42	42	Slip 3 - North End (Berth 27)
43	43	Slip 2 - North End (Berth 19)
44	44	Slip 1 - North End (Berth 11)
45	46	Berth 87 - Texaco Terminal
46	--	Berth 85 - Texaco Terminal
47	47	Island Grissom - South Side
48	--	2000 ft West of Island Grissom
49	49	Queensway Bay - North/Q.M.
--	12	200-Acre Fill - South Face - West
--	13	200-Acre Fill - South Face - Center
--	14	200-Acre Fill - South Face - East

(Continued)

Table 1 (Concluded)

Base Plan	Modified Phase 1 Plan	Location
--	15	200-Acre Fill - East Face - South
--	16	200-Acre Fill - East Face - North
--	25	Long Beach Oil Terminal Basin - West Entrance
--	26	Long Beach Oil Terminal Basin - Berth 266
--	27	Long Beach Oil Terminal Basin - Berth 265
--	28	Long Beach Oil Terminal Basin - Berth 264
--	29	Pier J South Face - Center
--	30	Long Beach Oil Terminal B.W. - Inside - SW Corner
--	31	Long Beach Oil Terminal B.W. - Inside - SE Corner
--	48	Long Beach Oil Terminal Basin - Berth 263

(Sheet 3 of 3)

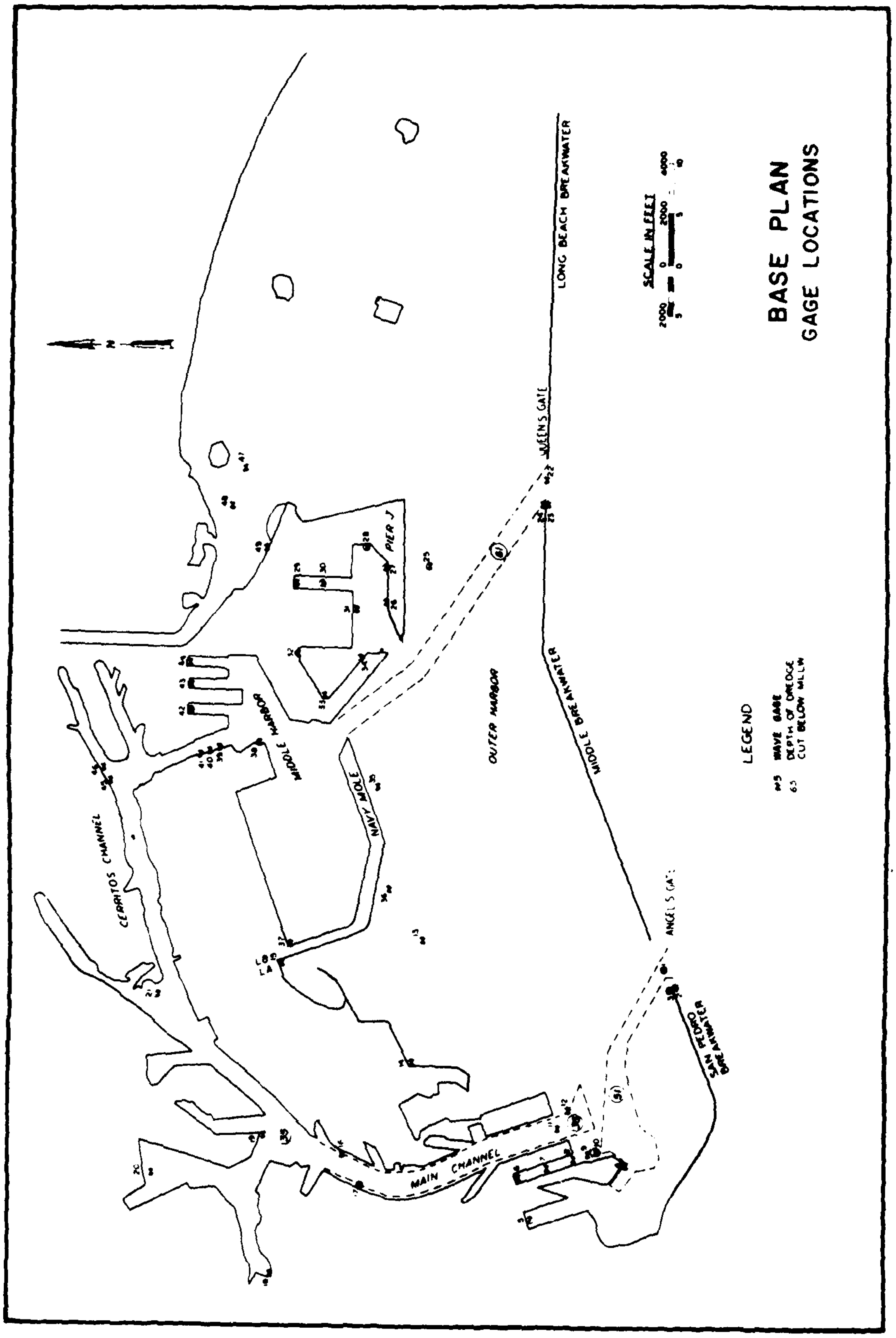

BASE PLAN
GAGE LOCATIONS
SCALE IN FEET
2000 0 2000 4000
LONG BEACH BREAKWATER
QUEEN'S GATE
PIER J
OUTER HARBOR
MIDDLE BREAKWATER
MIDDLE HARBOR
NAVY MOLE
CERRITOS CHANNEL
MAIN CHANNEL
ANGEL'S GATE
SAN PEDRO BREAKWATER
LEGEND
WAVE GAGE
DEPTH OF DREDGE CUT BELOW MLLW

PLATE 1

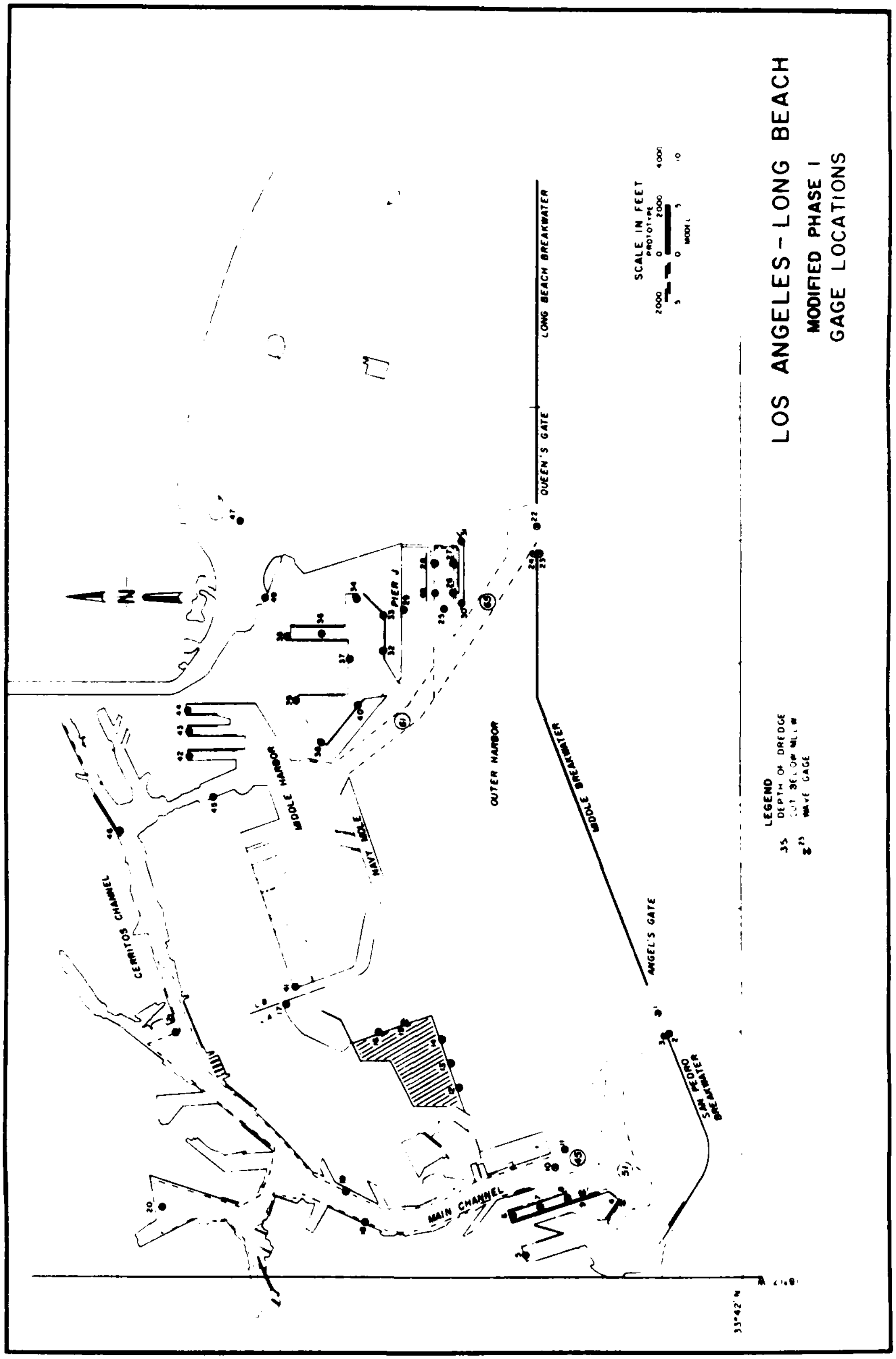
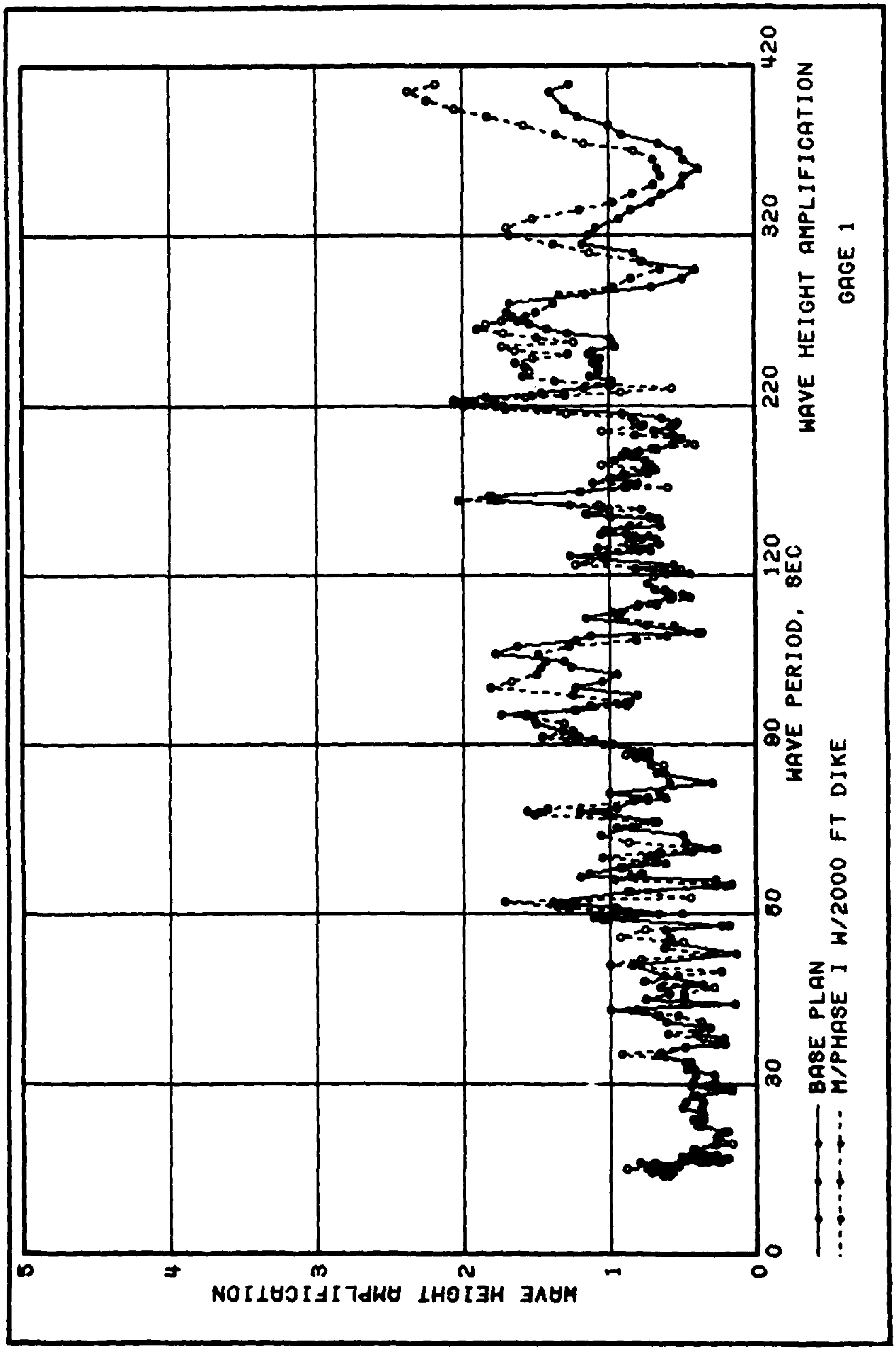
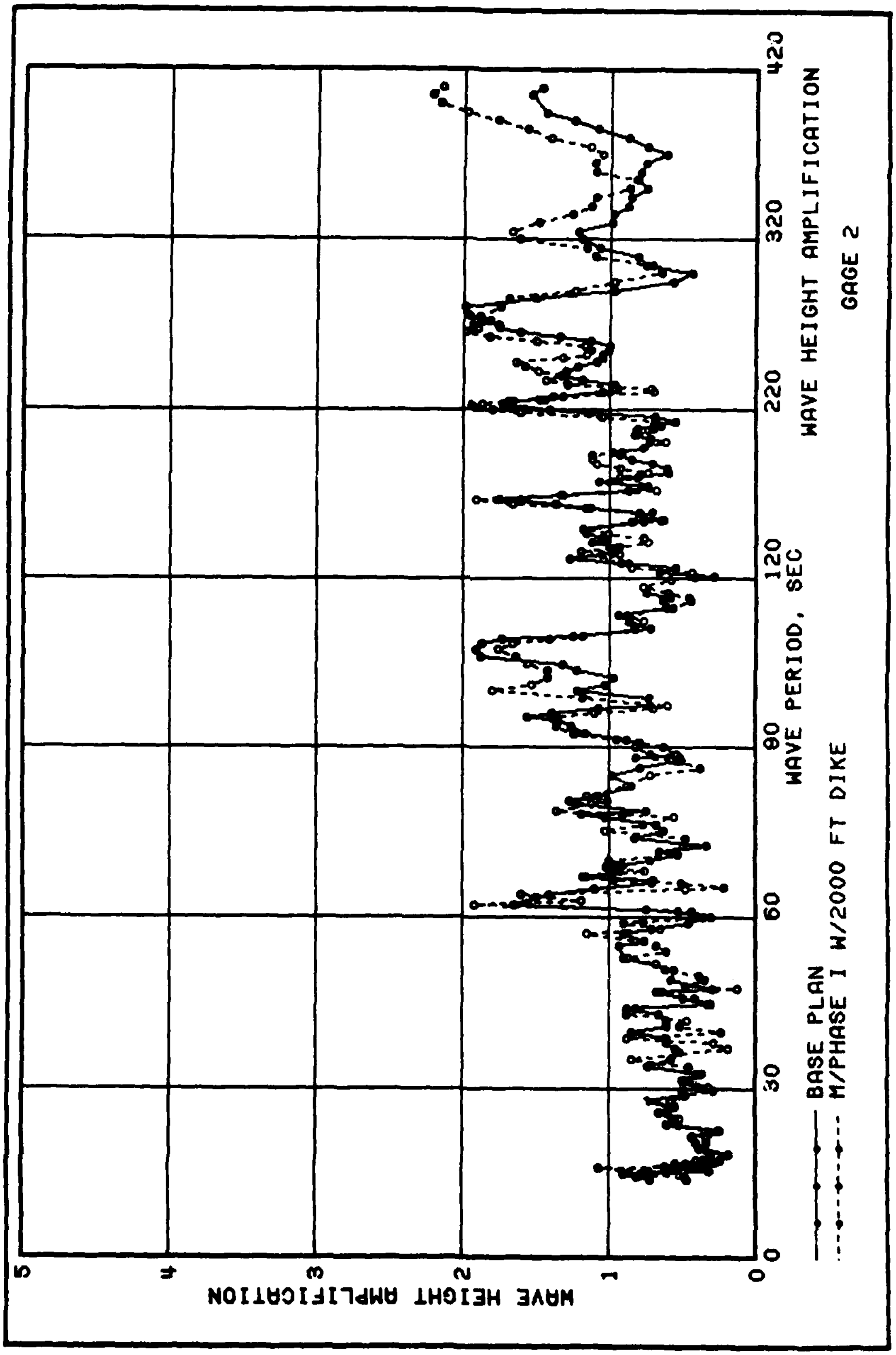

LOS ANGELES - LONG BEACH
MODIFIED PHASE I
GAGE LOCATIONS
SCALE IN FEET
LEGEND
LONG BEACH BREAKWATER
QUEEN'S GATE
PIER J
OUTER HARBOR
MIDDLE BREAKWATER
MIDDLE HARBOR
NAVY MOLE
CERRITOS CHANNEL
ANGEL'S GATE
SAN PEDRO BREAKWATER
MAIN CHANNEL

PLATE 2


WAVE HEIGHT AMPLIFICATION
GAGE 1
WAVE HEIGHT AMPLIFICATION
WAVE PERIOD, SEC
0
30
60
90
120
220
320
420
0
1
2
3
4
5
BASE PLAN
W/PHASE I W/2000 FT DIKE



WAVE HEIGHT AMPLIFICATION
GAGE 2
WAVE HEIGHT AMPLIFICATION
WAVE PERIOD, SEC
0
1
2
3
4
5
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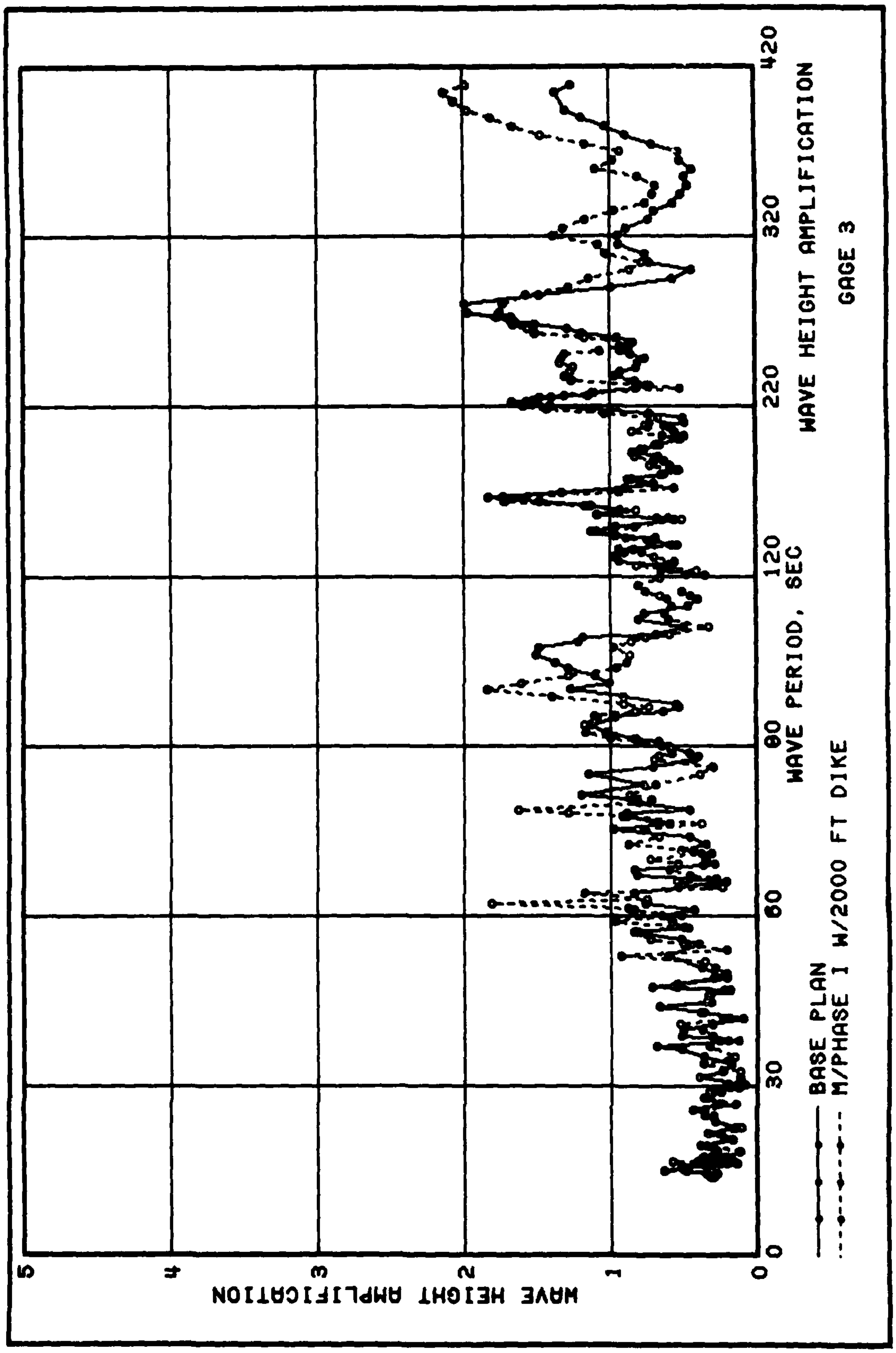
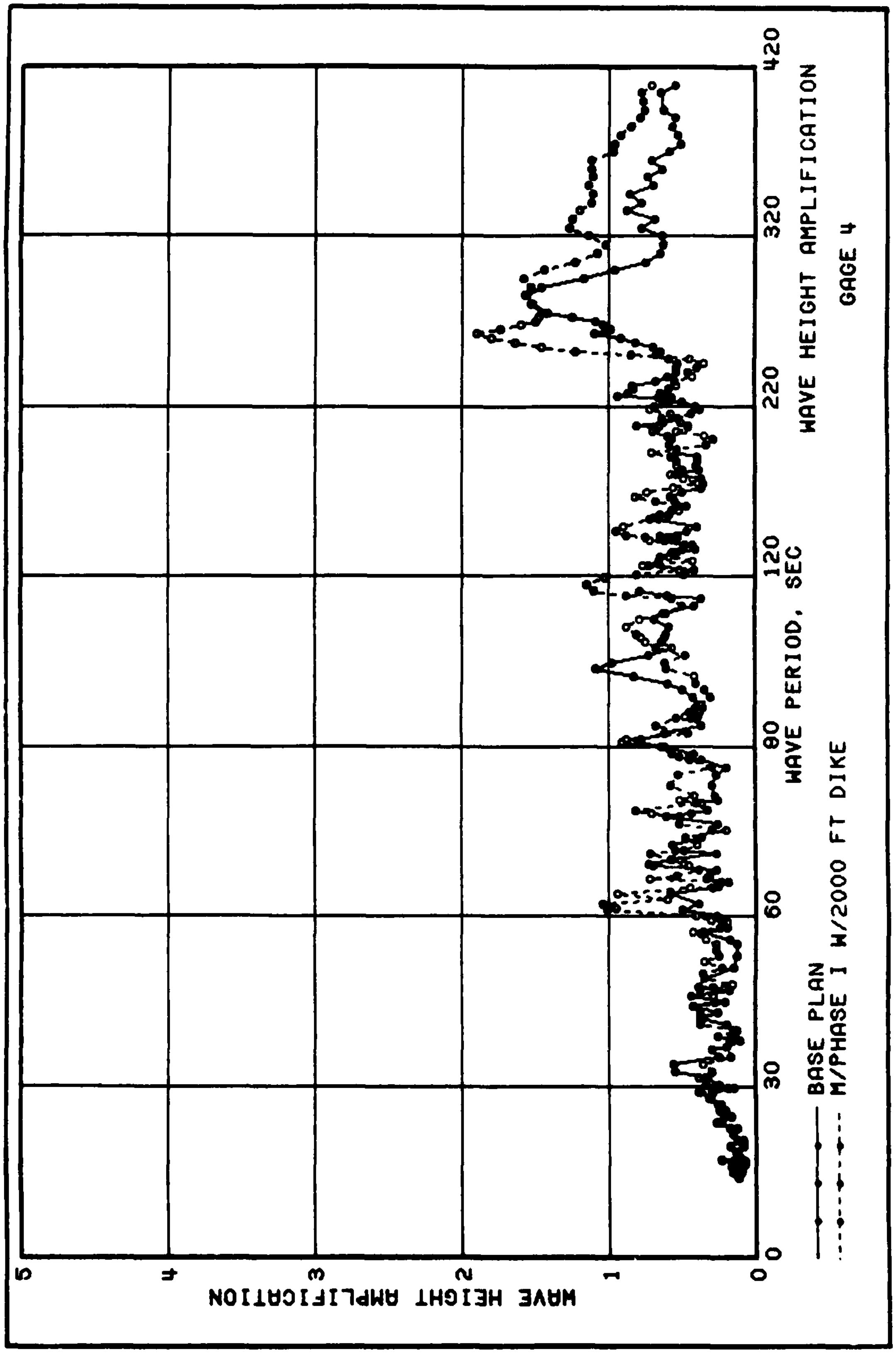
30
60
90
120
220
320
420
BASE PLAN
W/PHASE I W/2000 FT DIKE

PLATE 4



WAVE HEIGHT AMPLIFICATION
GAGE 3
WAVE PERIOD, SEC
0
30
60
90
120
220
320
420
WAVE HEIGHT AMPLIFICATION
0
1
2
3
4
5
BASE PLAN
M/PHASE I W/2000 FT DIKE

PLATE 5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GAGE 4
WAVE HEIGHT AMPLIFICATION
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30
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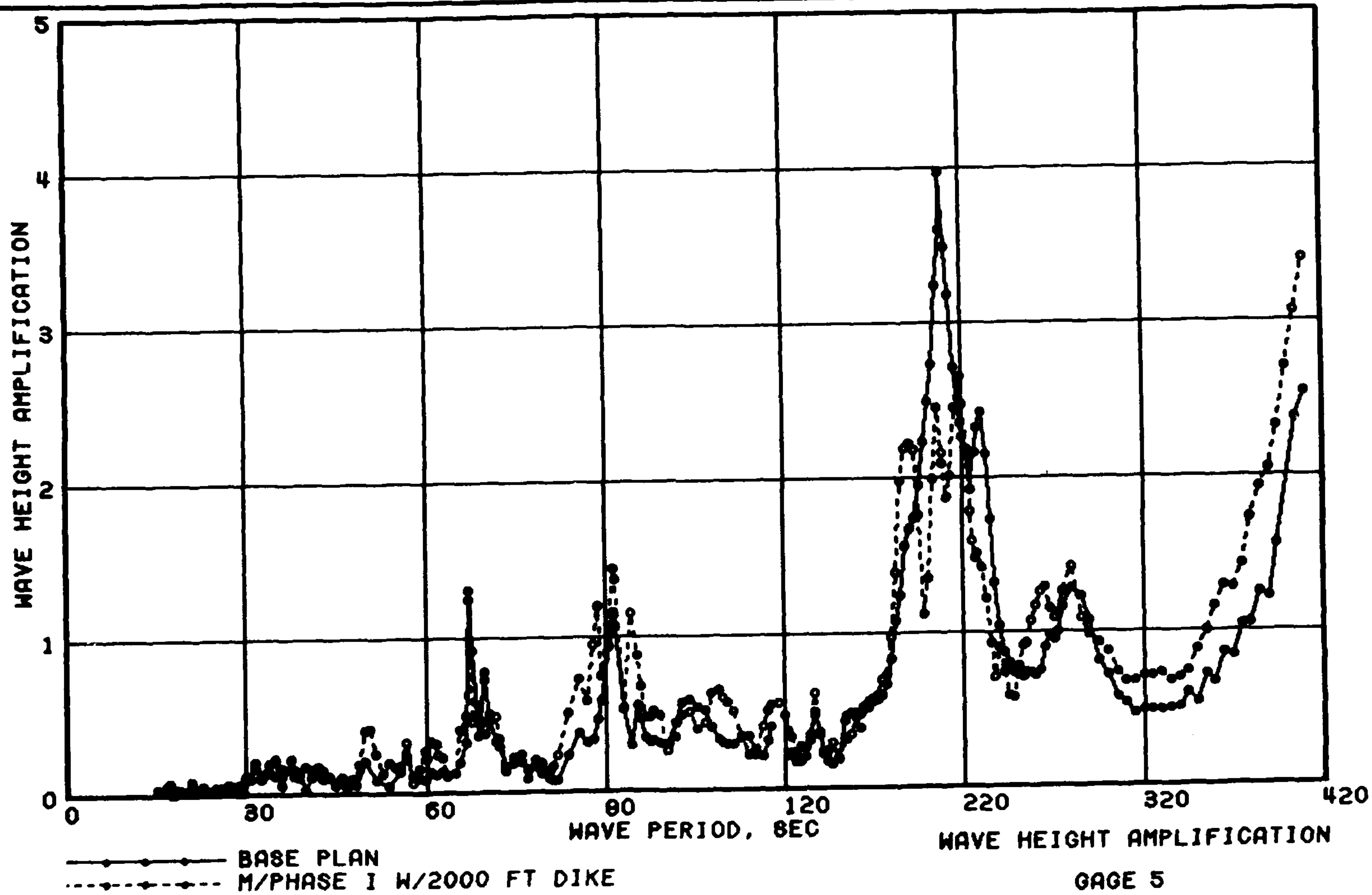
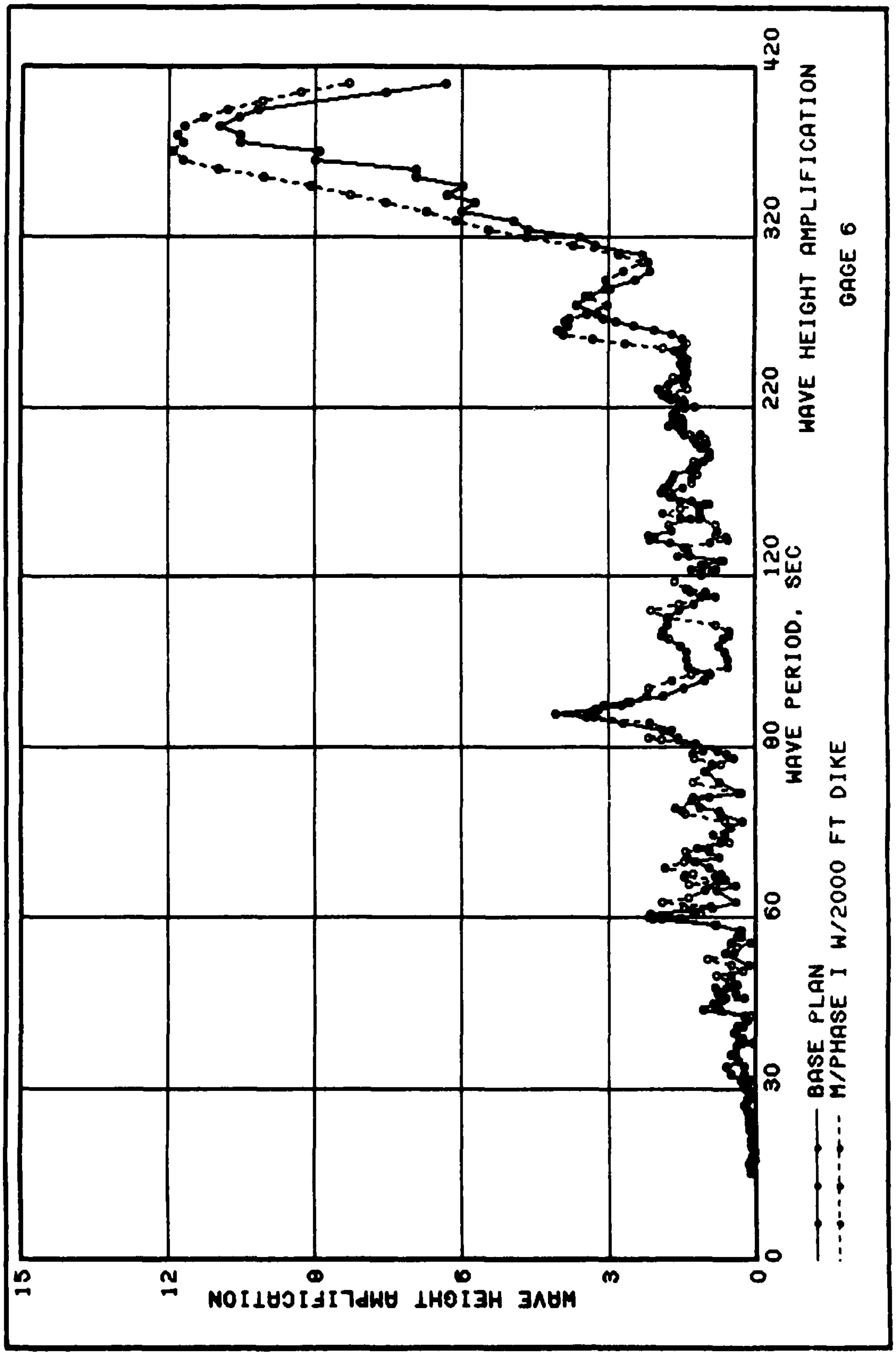
1
2
3
4
5
BASE PLAN
W/PHASE I W/2000 FT DIKE

PLATE 6



WAVE HEIGHT AMPLIFICATION

GAGE 5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GAGE 6
WAVE PERIOD, SEC
WAVE HEIGHT AMPLIFICATION
BASE PLAN
M/PHASE I W/2000 FT DIKE
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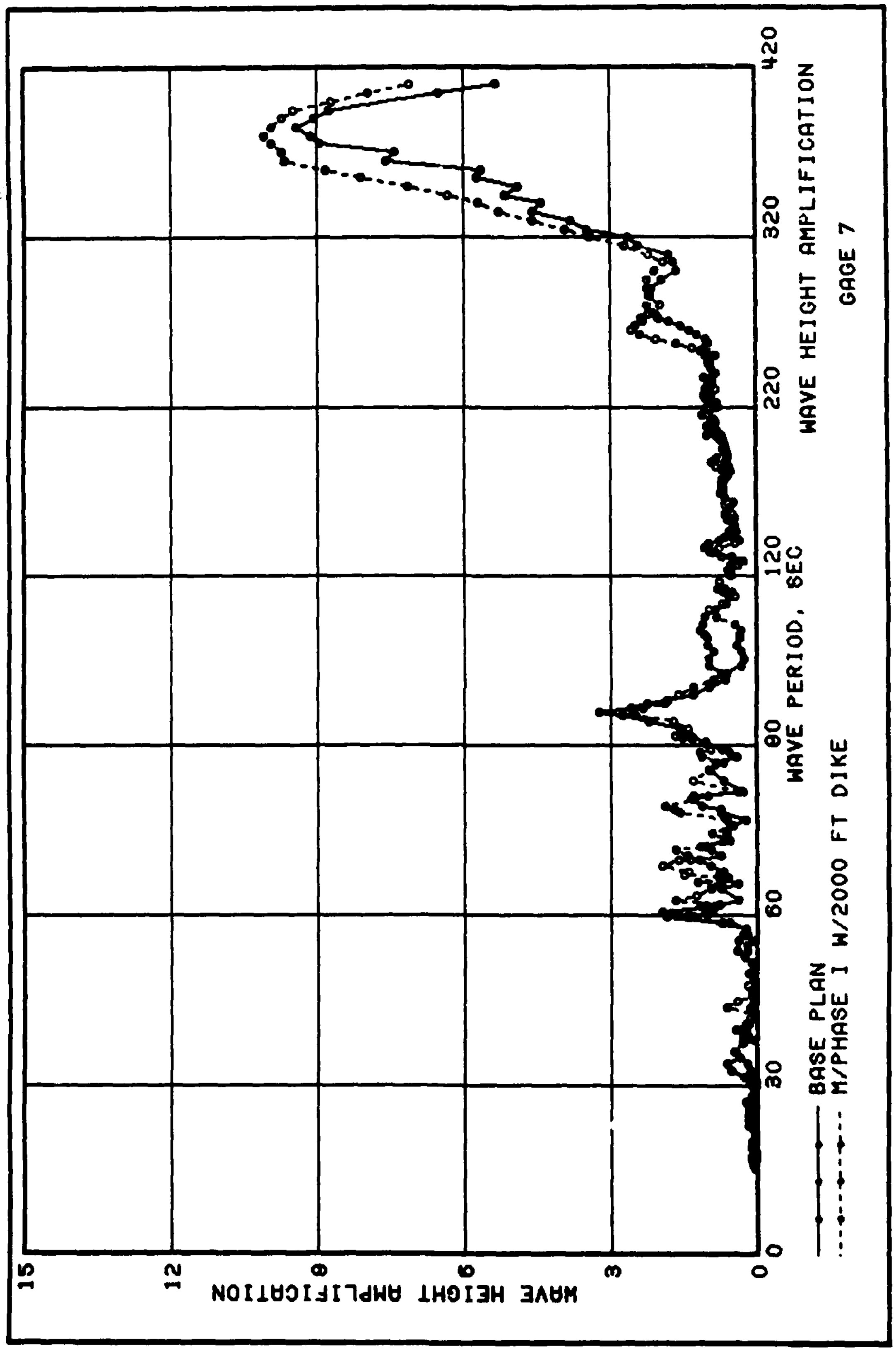
6
9
12
15
0
30
60
90
120
220
320
420

PLATE 8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GAGE 7
WAVE HEIGHT AMPLIFICATION
WAVE PERIOD, SEC
0
30
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420
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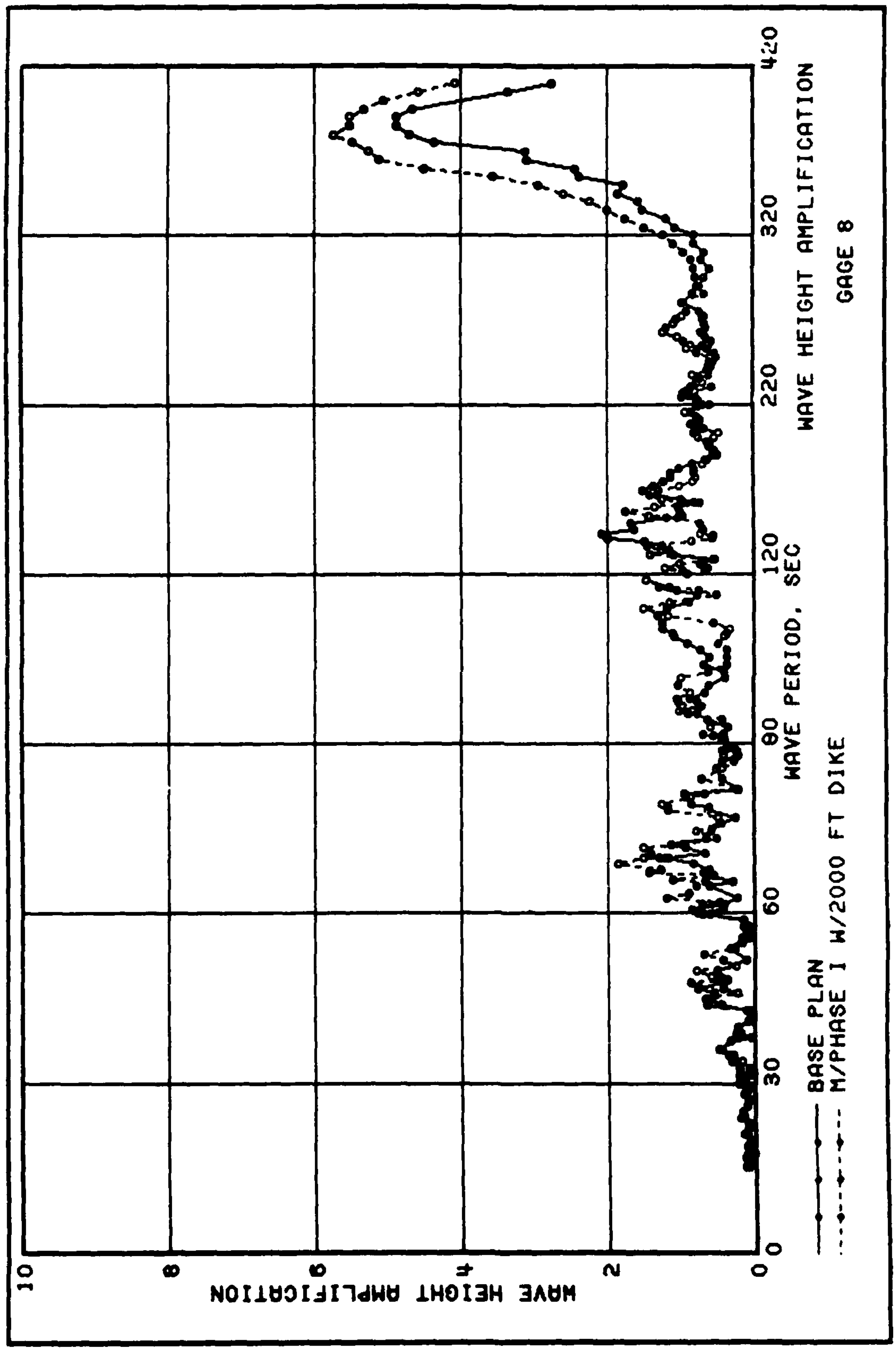
3
6
9
12
15
BASE PLAN
M/PHASE I W/2000 FT DIKE

PLATE 9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WAVE PERIOD, SEC
WAVE HEIGHT AMPLIFICATION
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M/PHASE I W/2000 FT DIKE
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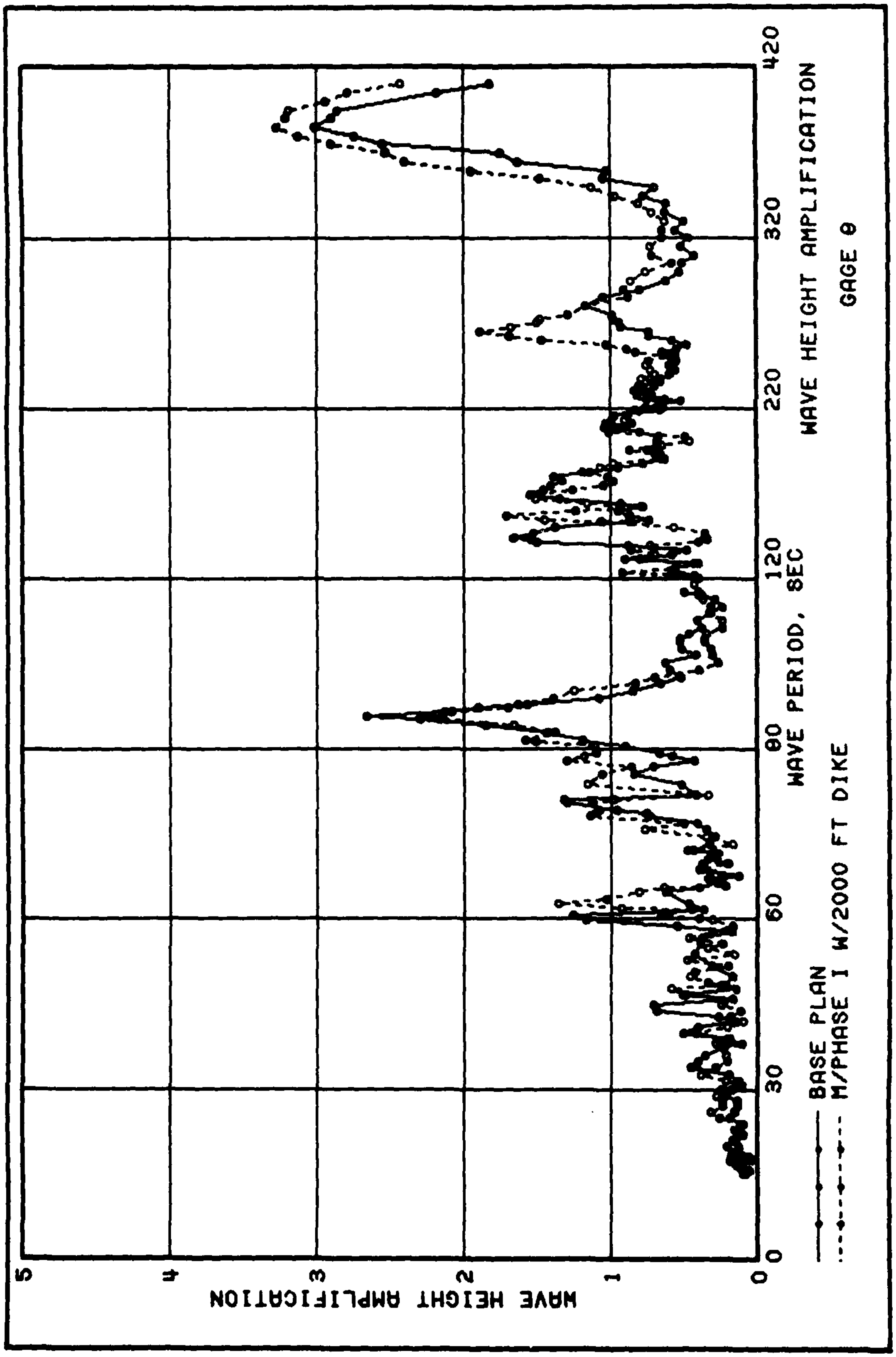
2
4
6
8
10

PLATE 10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GAGE 8
WAVE PERIOD, SEC
WAVE HEIGHT AMPLIFICATION
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1
2
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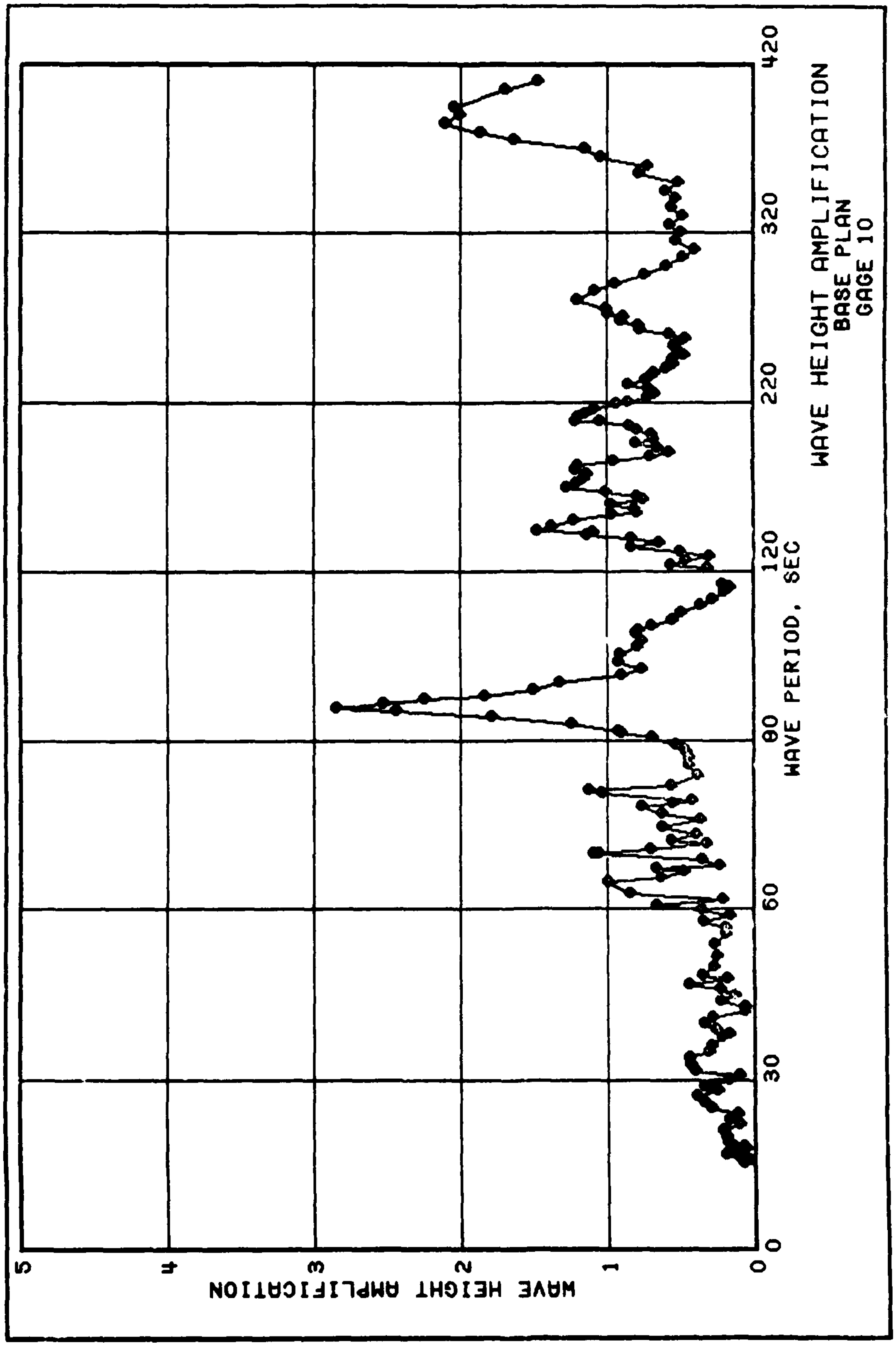
BASE PLAN
W/PHASE I W/2000 FT DIKE

PLATE 11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BASE PLAN
GAGE 10
WAVE PERIOD, SEC
WAVE HEIGHT AMPLIFICATION
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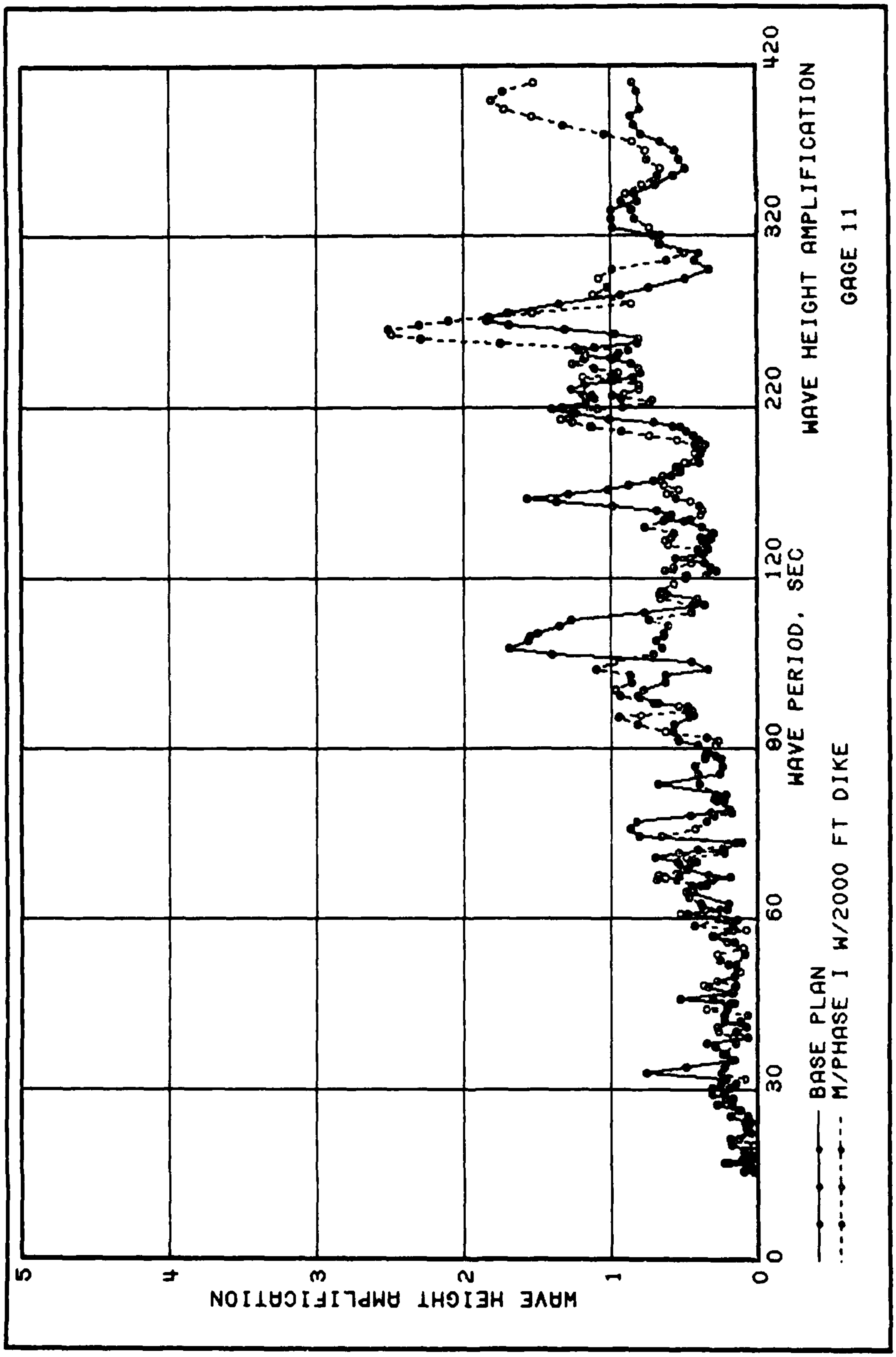
2
3
4
5

PLATE 12



WAVE HEIGHT AMPLIFICATION
GAGE 11
WAVE PERIOD, SEC
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60
90
120
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320
420
WAVE HEIGHT AMPLIFICATION
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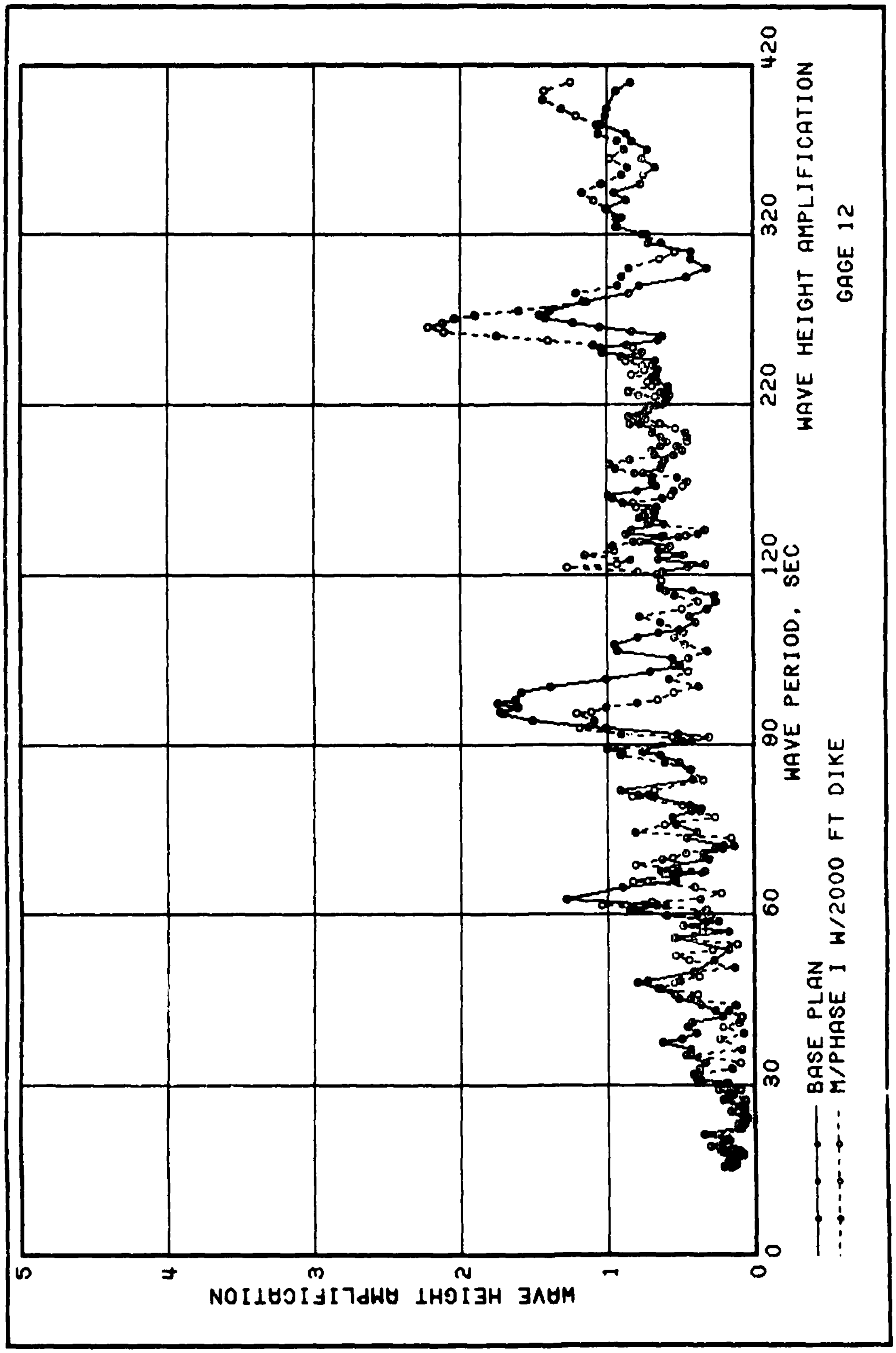
1
2
3
4
5
BASE PLAN
W/PHASE I W/2000 FT DIKE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GAGE 12
WAVE PERIOD, SEC
WAVE HEIGHT AMPLIFICATION
0
1
2
3
4
5
0
30
60
90
120
220
320
420
BASE PLAN
M/PHASE I W/2000 FT DIKE

PLATE 14

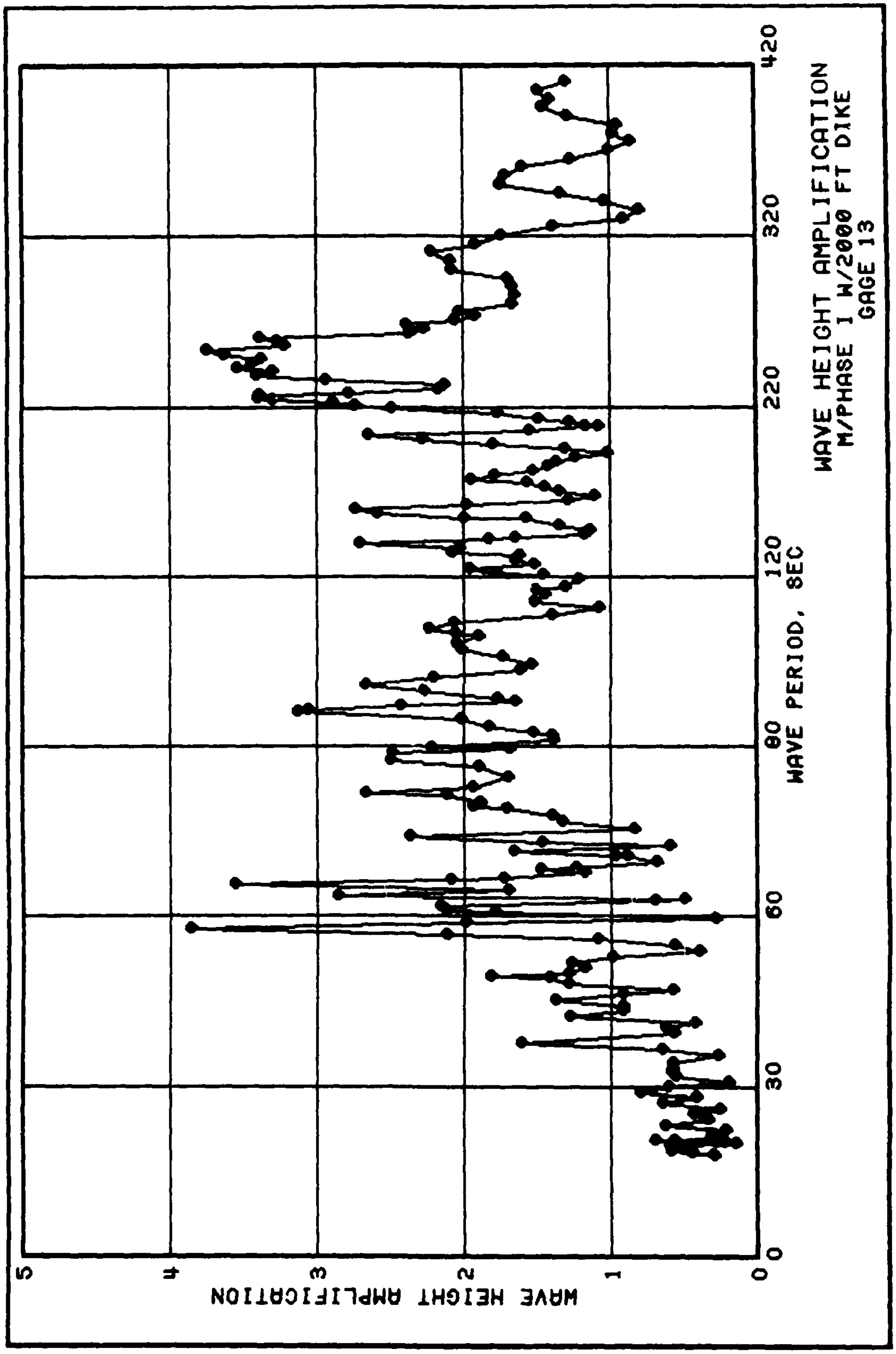

WAVE HEIGHT AMPLIFICATION
M/PHASE 1 W/2000 FT DIKE
GAGE 13
WAVE PERIOD, SEC
0
30
60
90
120
220
320
420
WAVE HEIGHT AMPLIFICATION
0
1
2
3
4
5

PLATE 15

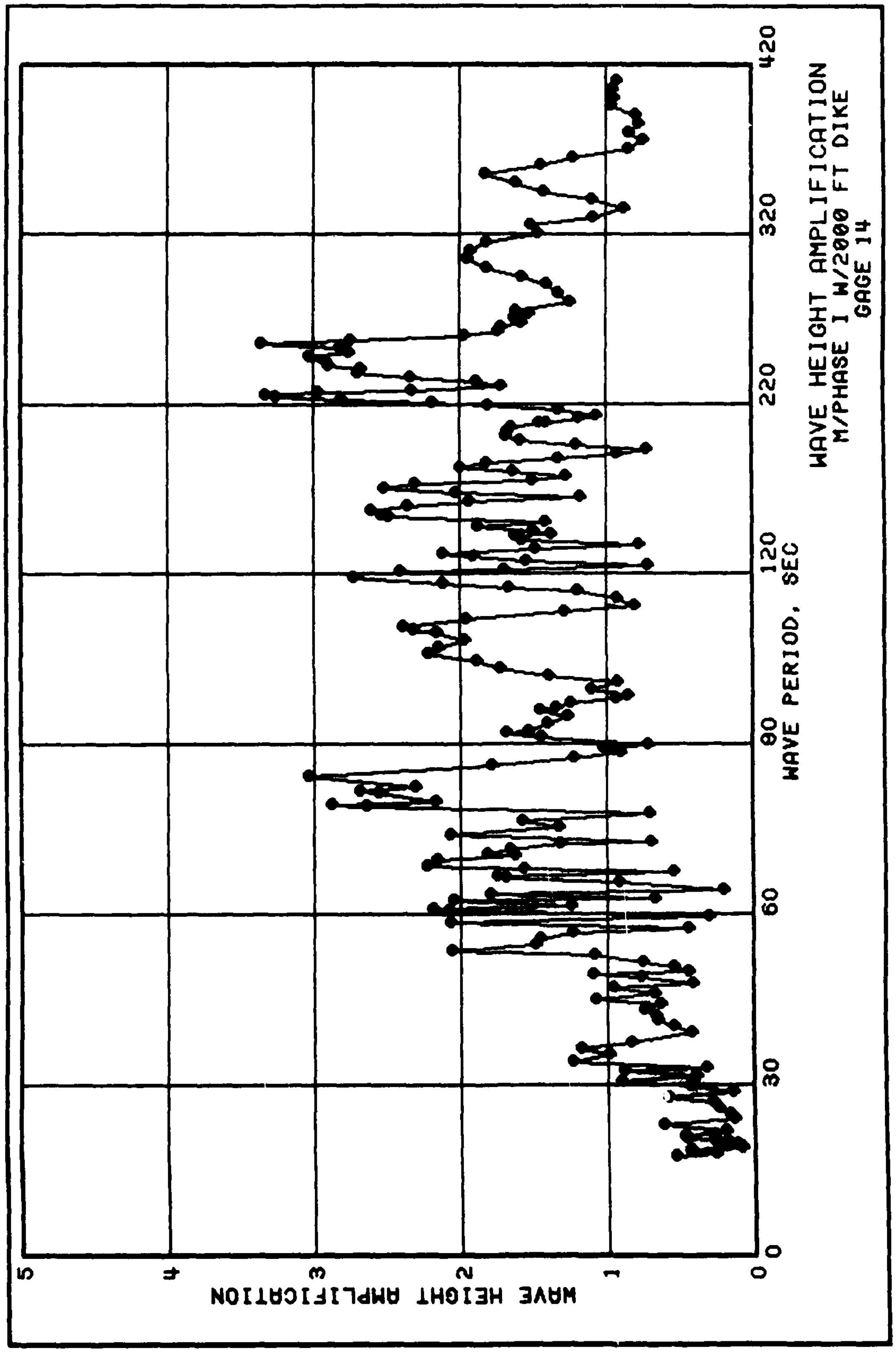
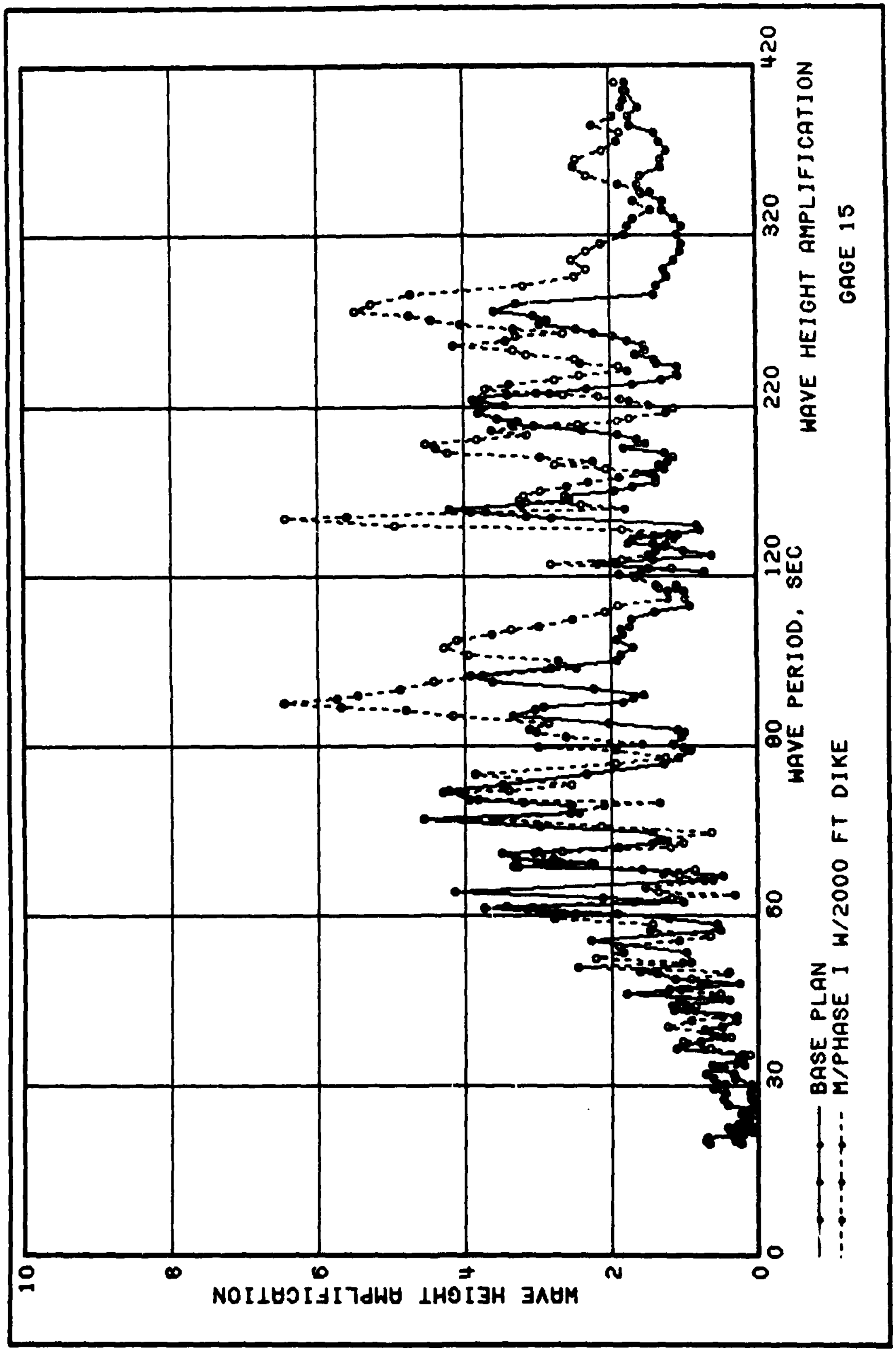

WAVE HEIGHT AMPLIFICATION
M/PHASE I W/2000 FT DIKE
GAGE 14
WAVE PERIOD, SEC
0
30
60
90
120
220
320
420
WAVE HEIGHT AMPLIFICATION
0
1
2
3
4
5

PLATE 16


WAVE HEIGHT AMPLIFICATION
GAGE 15
WAVE PERIOD, SEC
0
30
60
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120
220
320
420
WAVE HEIGHT AMPLIFICATION
0
2
4
6
8
10
BASE PLAN
M/PHASE I W/2000 FT DIKE

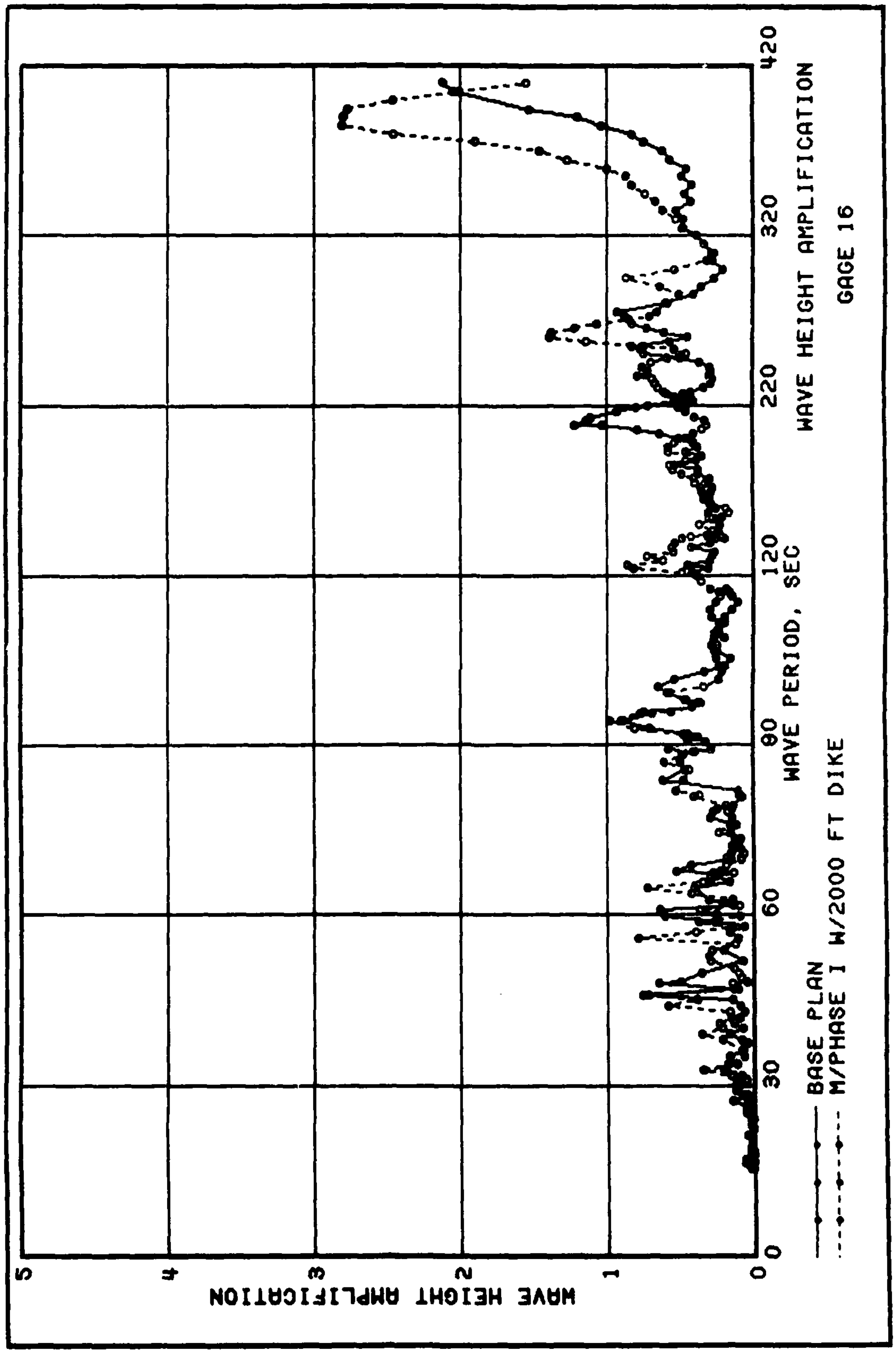
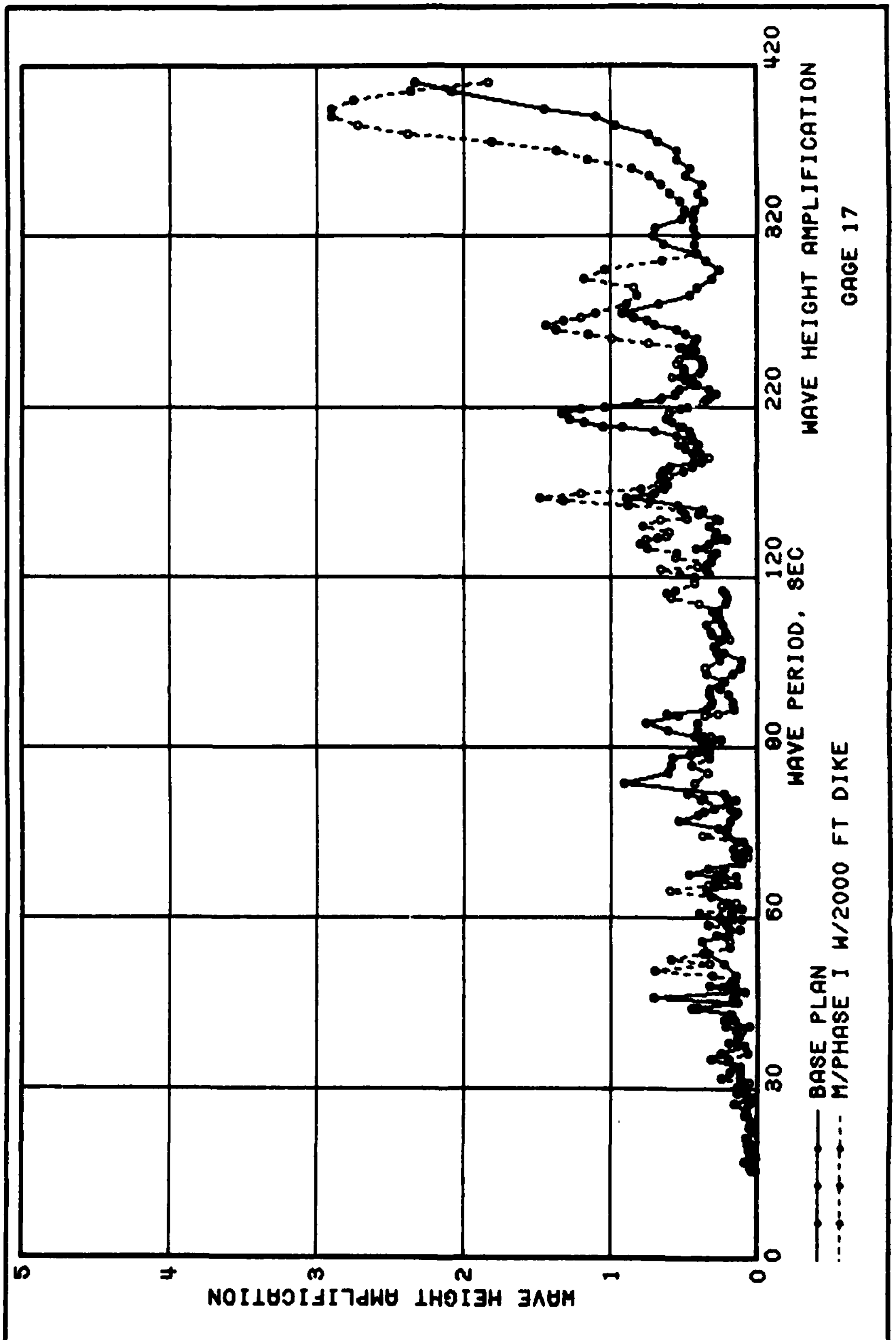

WAVE HEIGHT AMPLIFICATION
GAGE 16
WAVE PERIOD, SEC
WAVE HEIGHT AMPLIFICATION
0
30
60
90
120
220
320
420
0
1
2
3
4
5
BASE PLAN
M/PHASE I W/2000 FT DIKE

PLATE 18


WAVE HEIGHT AMPLIFICATION
GAGE 17
WAVE HEIGHT AMPLIFICATION
WAVE PERIOD, SEC
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30
60
90
120
220
320
420
0
1
2
3
4
5
BASE PLAN
M/PHASE I W/2000 FT DIKE

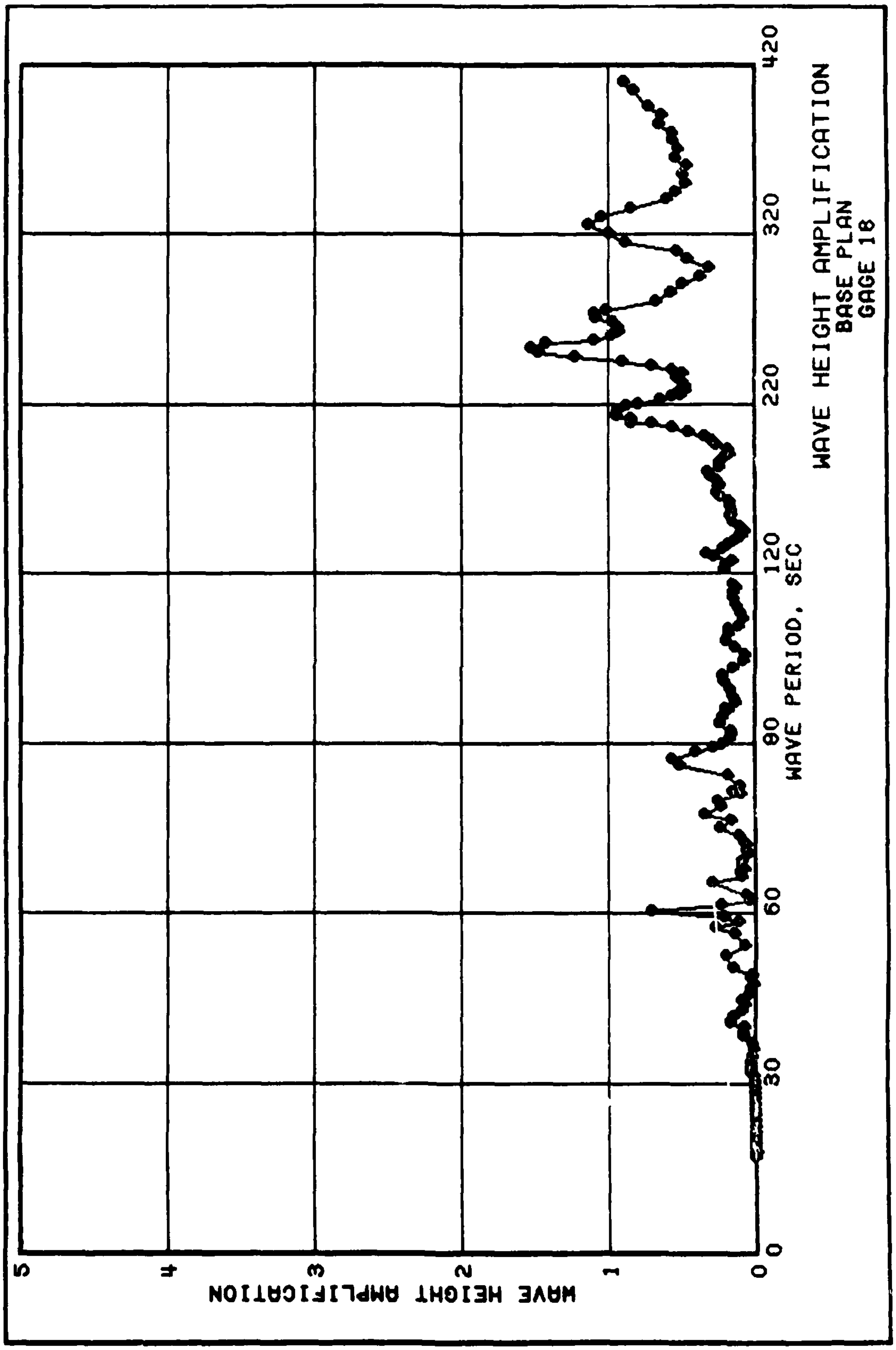
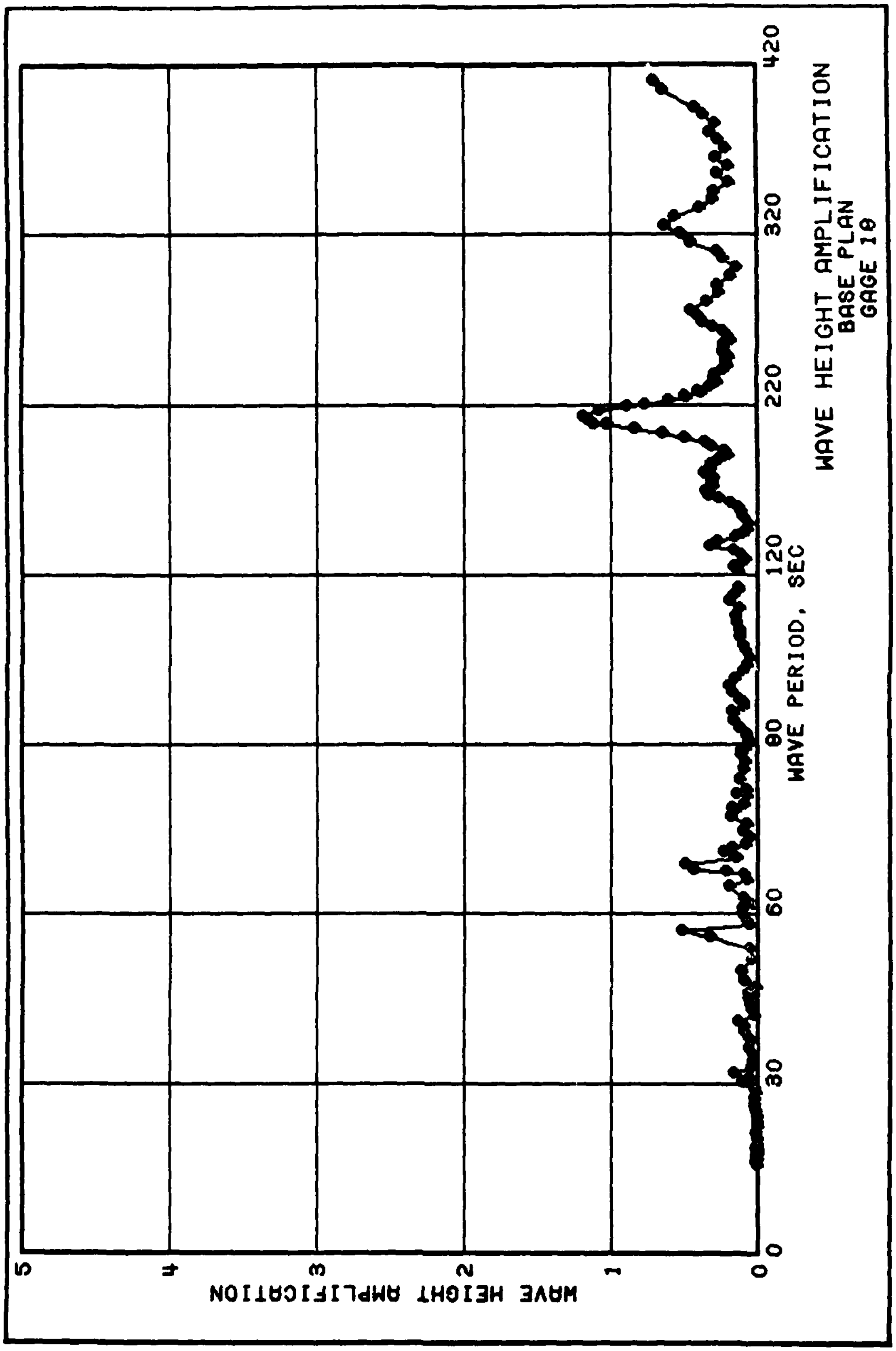

WAVE HEIGHT AMPLIFICATION
BASE PLAN
GAGE 18
WAVE PERIOD, SEC
WAVE HEIGHT AMPLIFICATION
0
30
60
90
120
220
320
420
0
1
2
3
4
5

PLATE 20


WAVE HEIGHT AMPLIFICATION
BASE PLAN
GAGE 10
WAVE HEIGHT AMPLIFICATION
WAVE PERIOD, SEC
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60
90
120
220
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420
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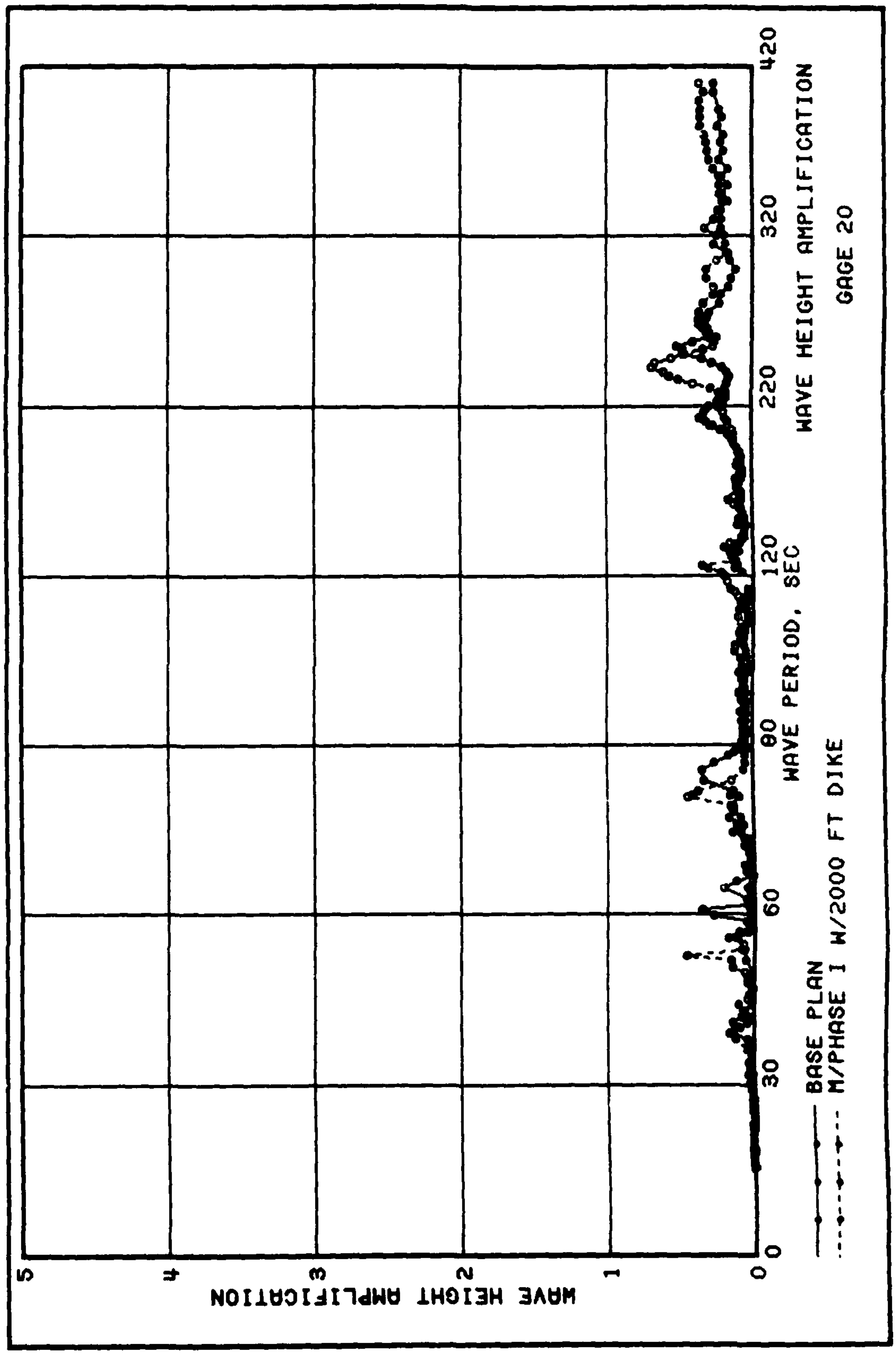
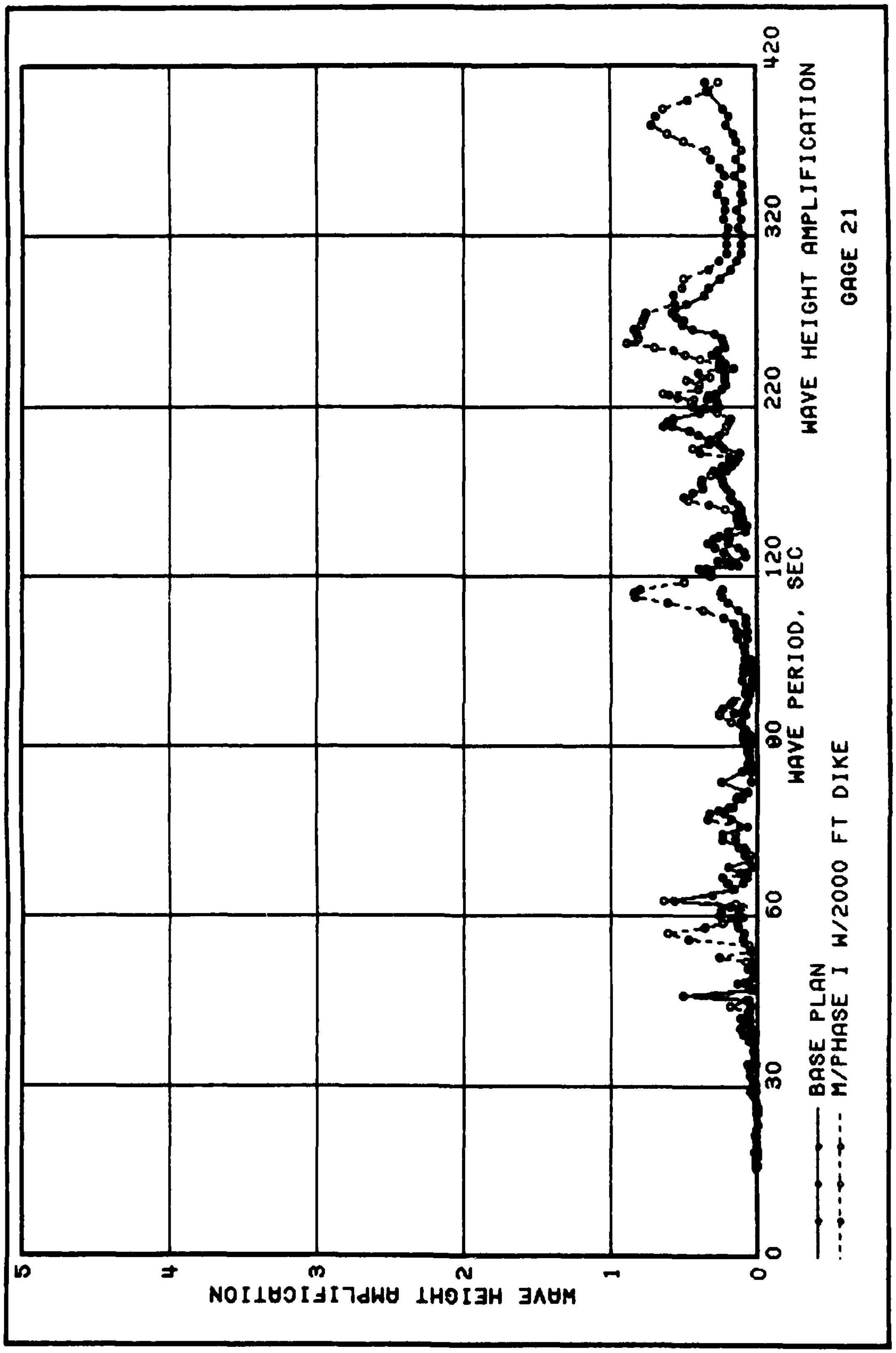
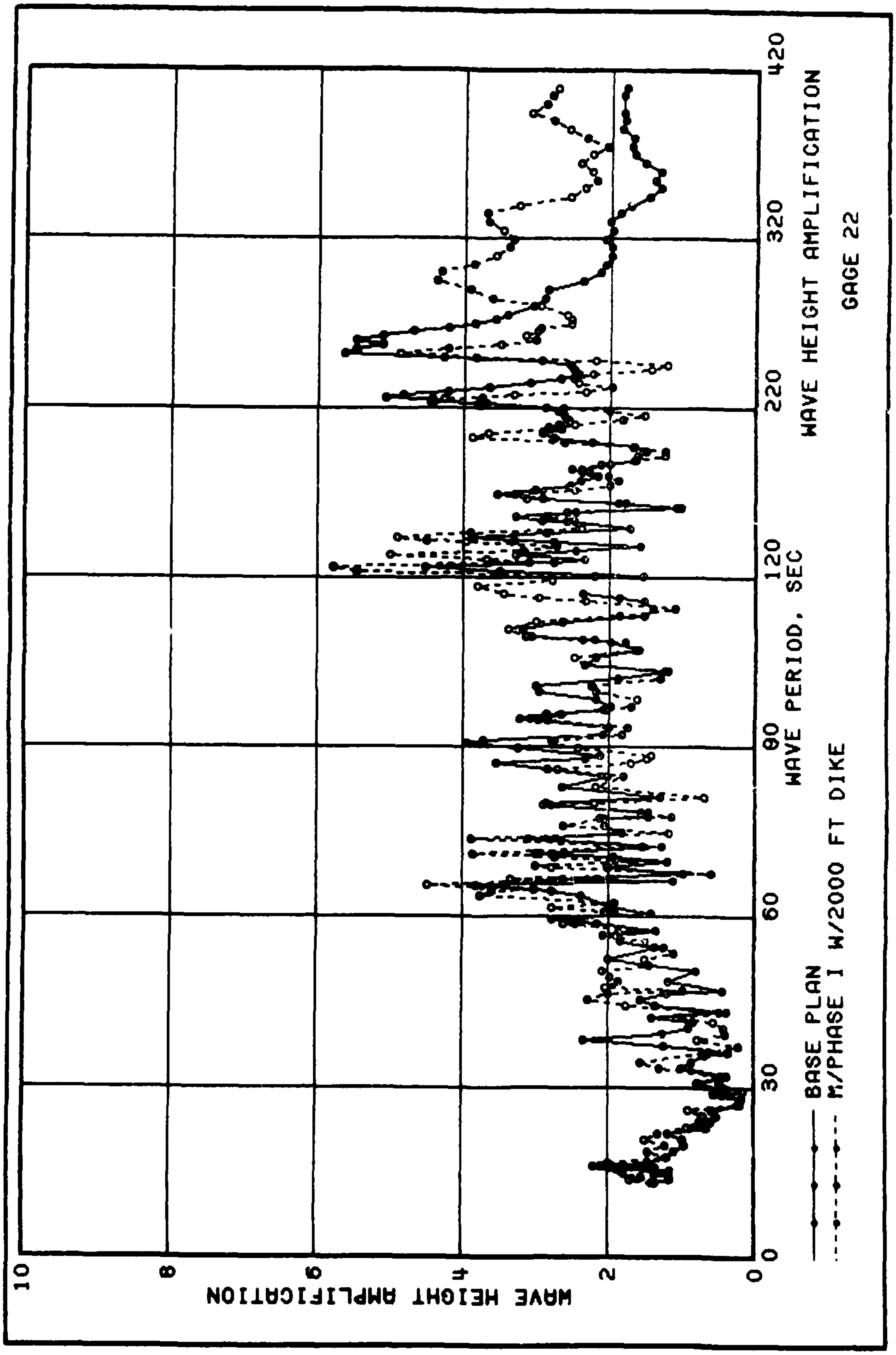
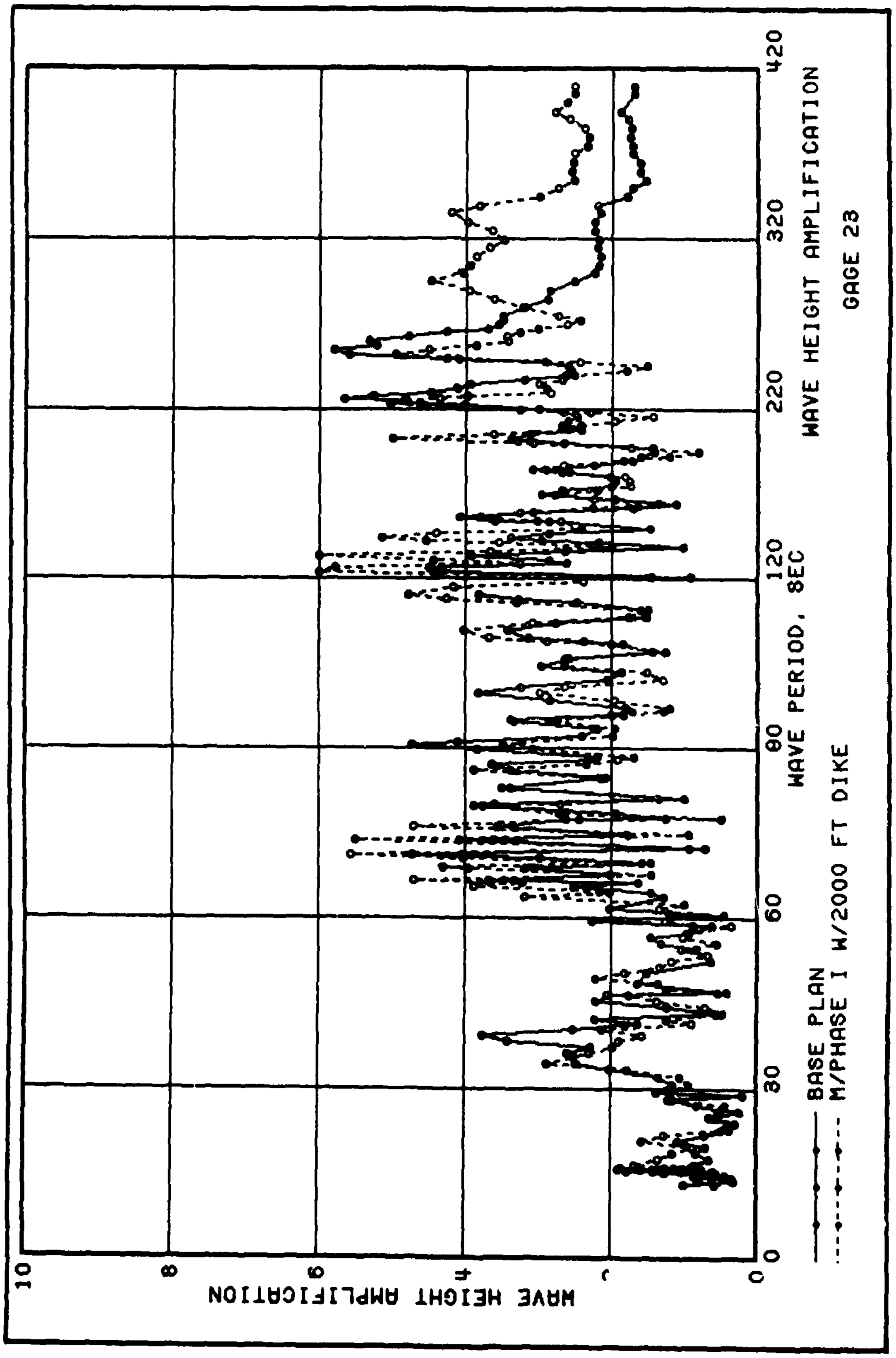
1
2
3
4
5


WAVE HEIGHT AMPLIFICATION
GAGE 20
WAVE PERIOD, SEC
WAVE HEIGHT AMPLIFICATION
BASE PLAN
M/PHASE I W/2000 FT DIKE
0
30
60
90
120
220
320
420
0
1
2
3
4
5


WAVE HEIGHT AMPLIFICATION
GAGE 21
WAVE HEIGHT AMPLIFICATION
WAVE PERIOD, SEC
BASE PLAN
M/PHASE I W/2000 FT DIKE
0
1
2
3
4
5
0
30
60
90
120
220
320
420


WAVE HEIGHT AMPLIFICATION
GAGE 22
WAVE PERIOD, SEC
WAVE HEIGHT AMPLIFICATION
BASE PLAN
M/PHASE I W/2000 FT DIKE
0
30
60
90
120
220
320
420
0
2
4
6
8
10


WAVE HEIGHT AMPLIFICATION
GAGE 23
WAVE HEIGHT AMPLIFICATION
WAVE PERIOD, SEC
BASE PLAN
M/PHASE I W/2000 FT DIKE
0
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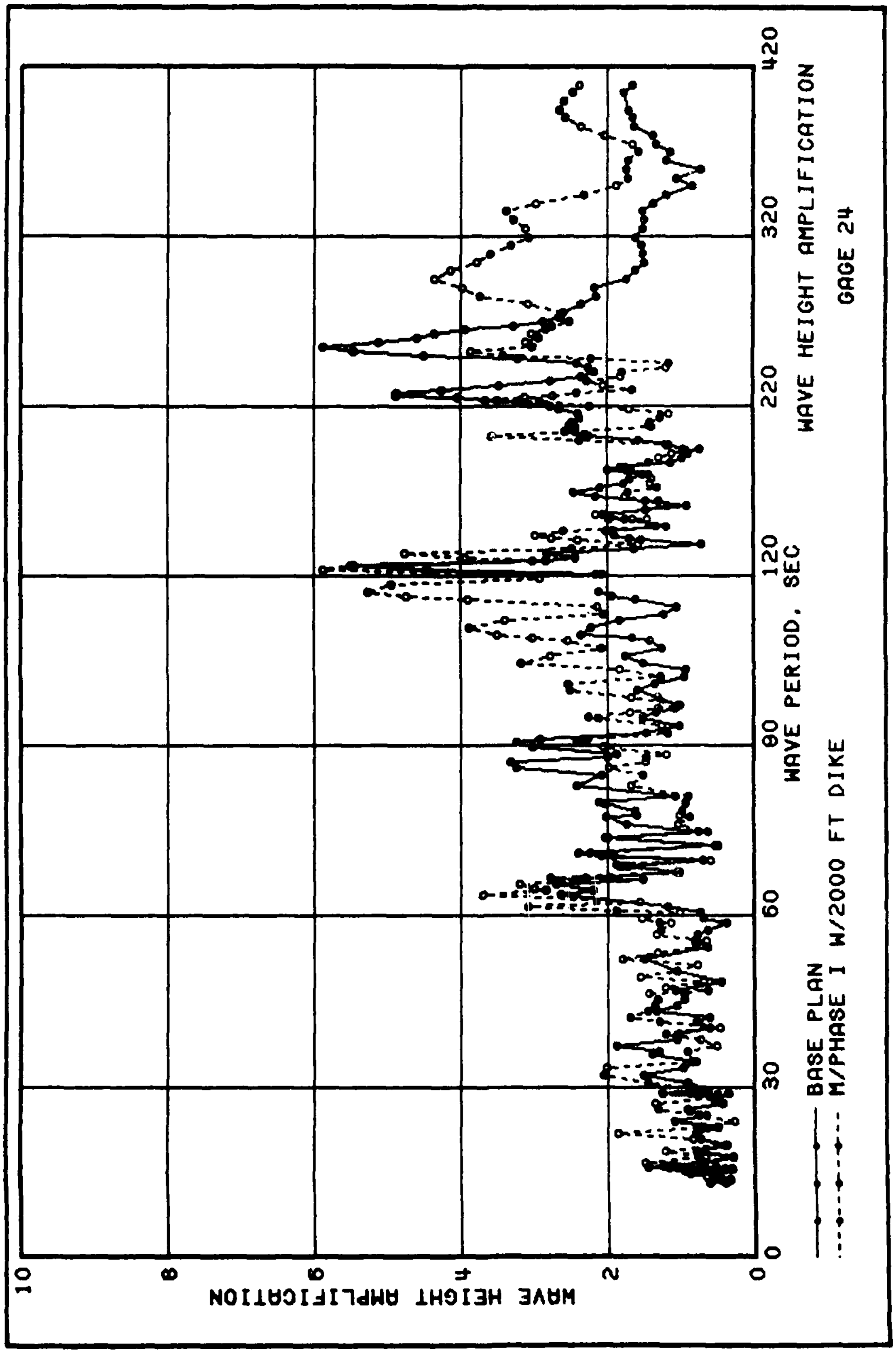
60
90
120
220
320
420
0
2
4
6
8
10


WAVE HEIGHT AMPLIFICATION
GAGE 24
WAVE PERIOD, SEC
WAVE HEIGHT AMPLIFICATION
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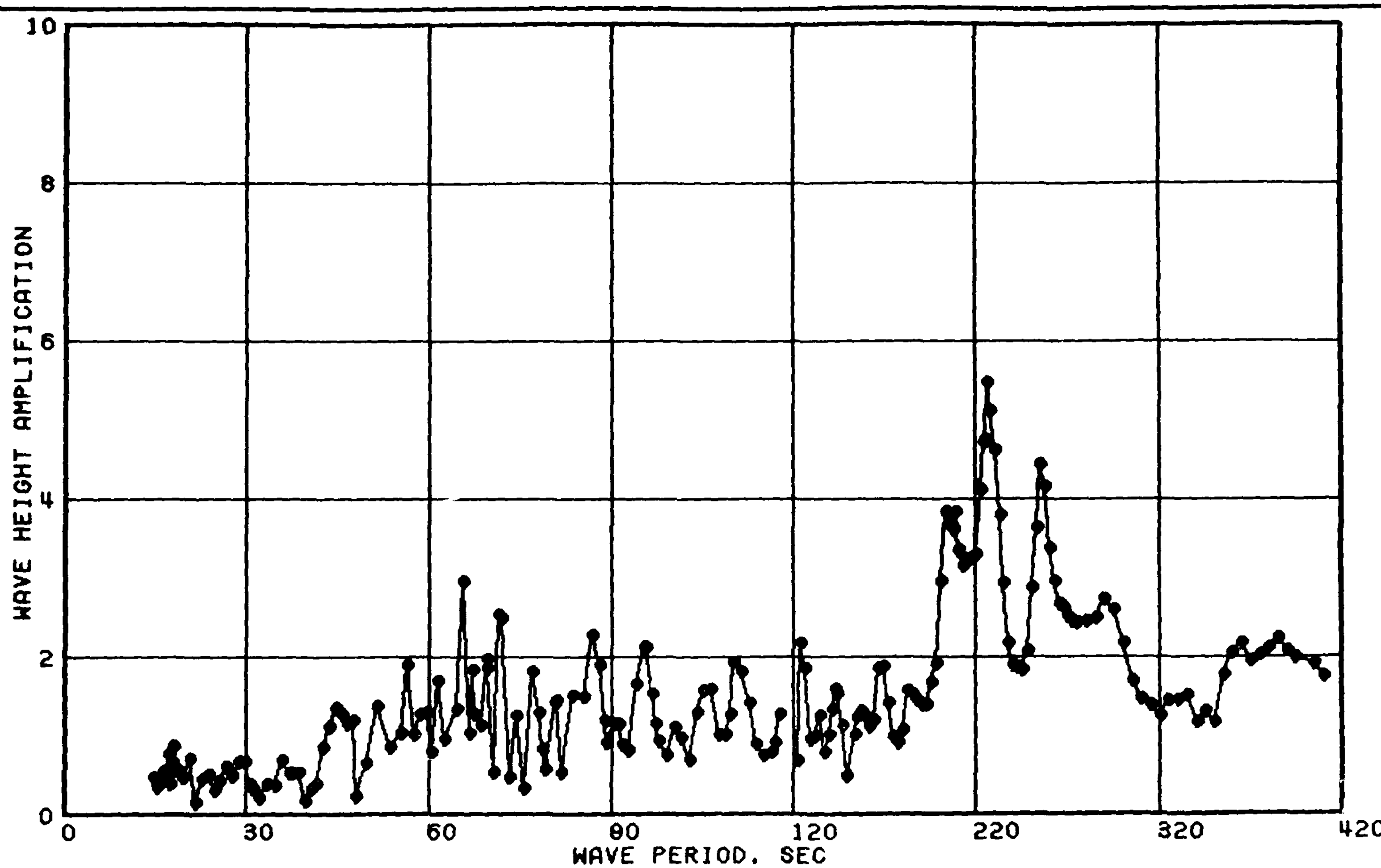
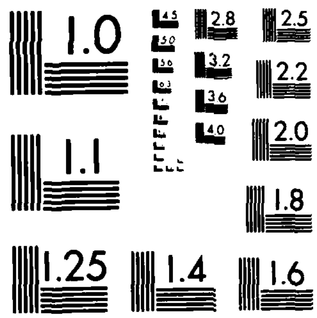
2
4
6
8
10
0
30
60
90
120
220
320
420
BASE PLAN
M/PHASE I W/2000 FT DIKE



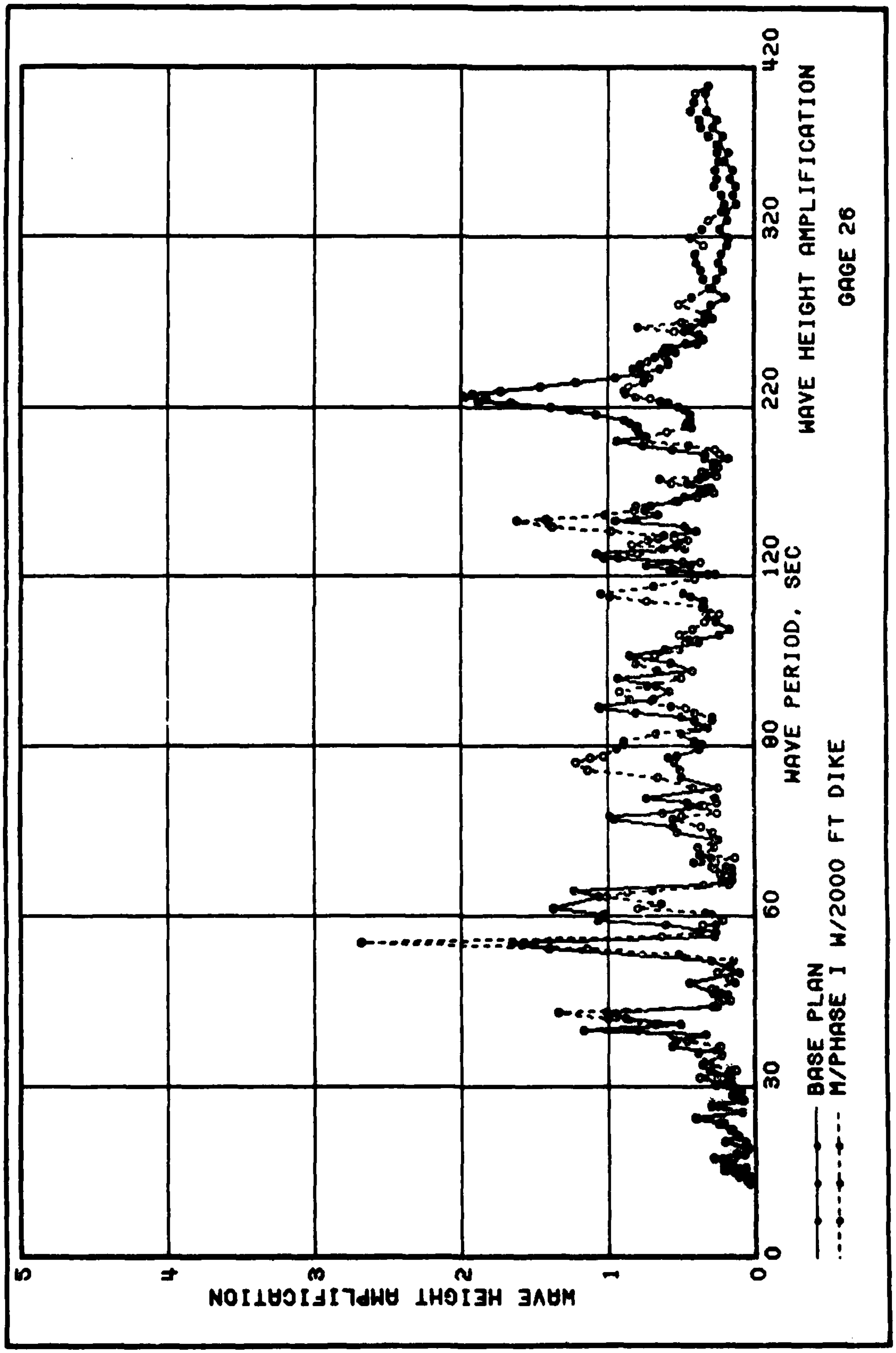
WAVE HEIGHT AMPLIFICATION
BASE PLAN
GAGE 25

AD-A171 216 LOS ANGELES - LONG BEACH HARBORS CALIFORNIA LOS ANGELES HARBOR DEEPENING..(U) ARMY ENGINEER DISTRICT LOS ANGELES CA JAN 80 5/6

UNCLASSIFIED F/G 13/2 NL

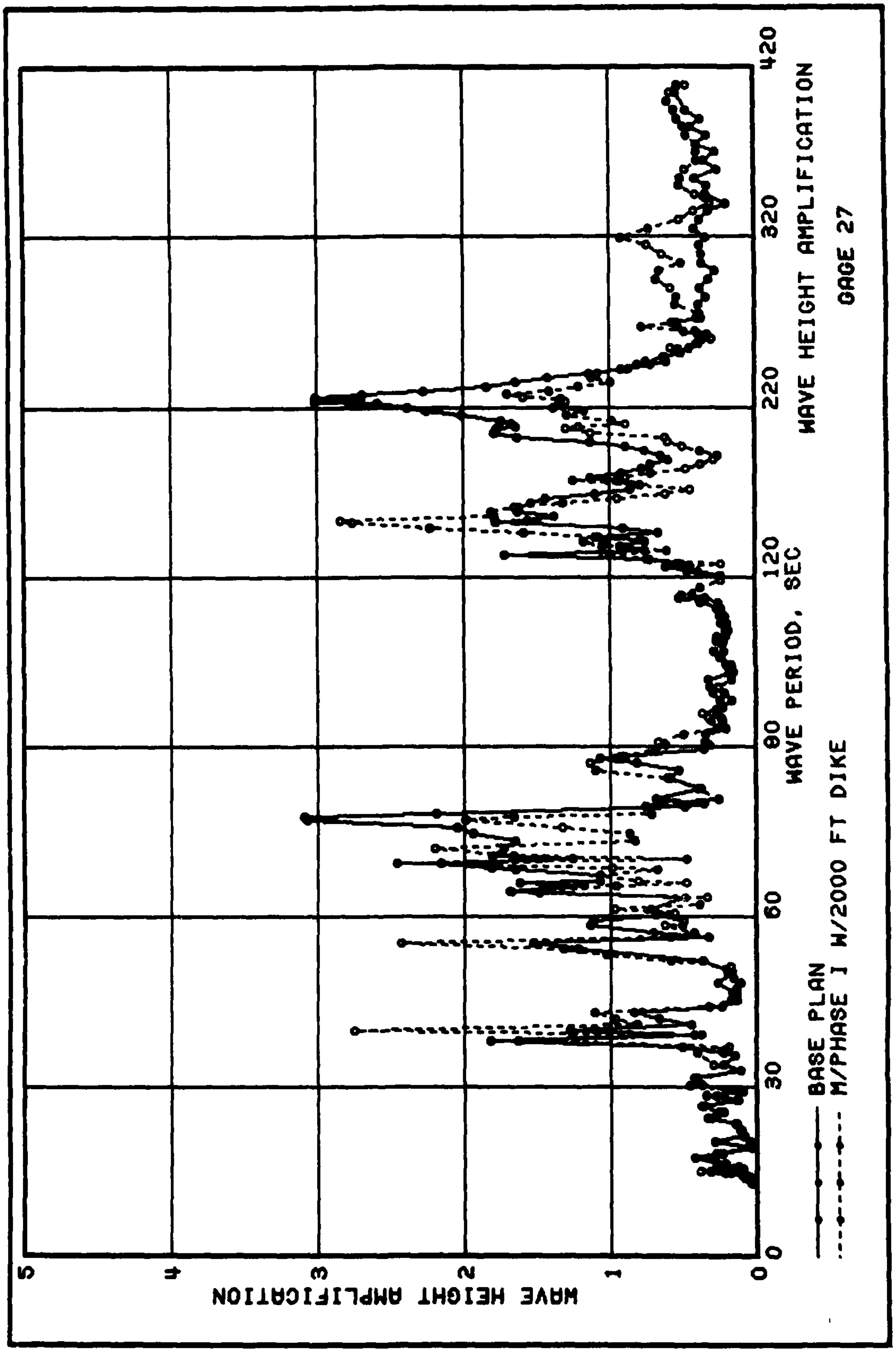


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A



WAVE HEIGHT AMPLIFICATION
GAGE 26
WAVE HEIGHT AMPLIFICATION
WAVE PERIOD, SEC
0
1
2
3
4
5
0
30
60
90
120
220
320
420
BASE PLAN
M/PHASE I W/2000 FT DIKE

PLATE 28


WAVE HEIGHT AMPLIFICATION
GAGE 27
WAVE HEIGHT AMPLIFICATION
WAVE PERIOD, SEC
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30
60
90
120
220
320
420
0
1
2
3
4
5
BASE PLAN
M/PHASE I W/2000 FT DIKE

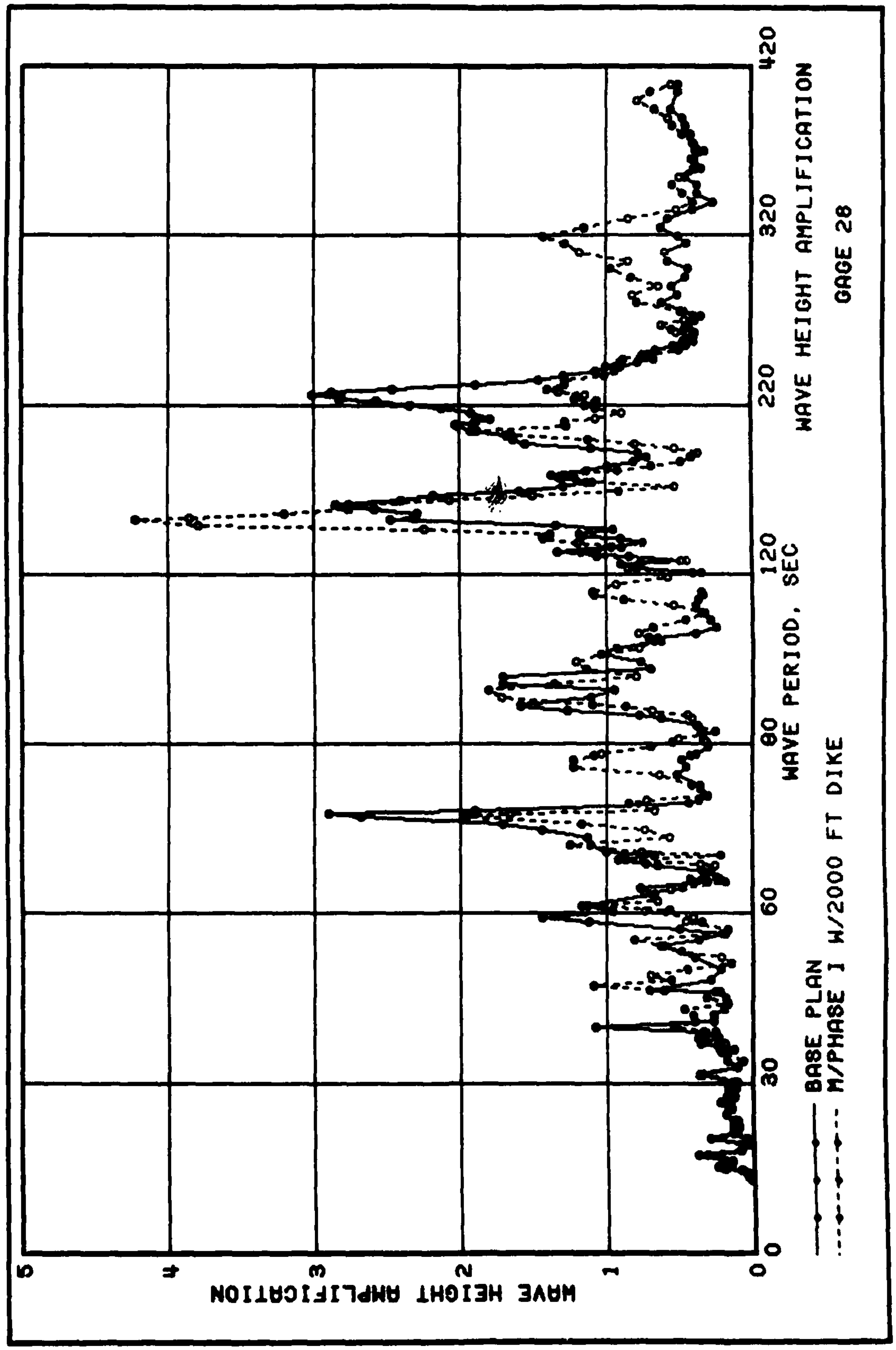
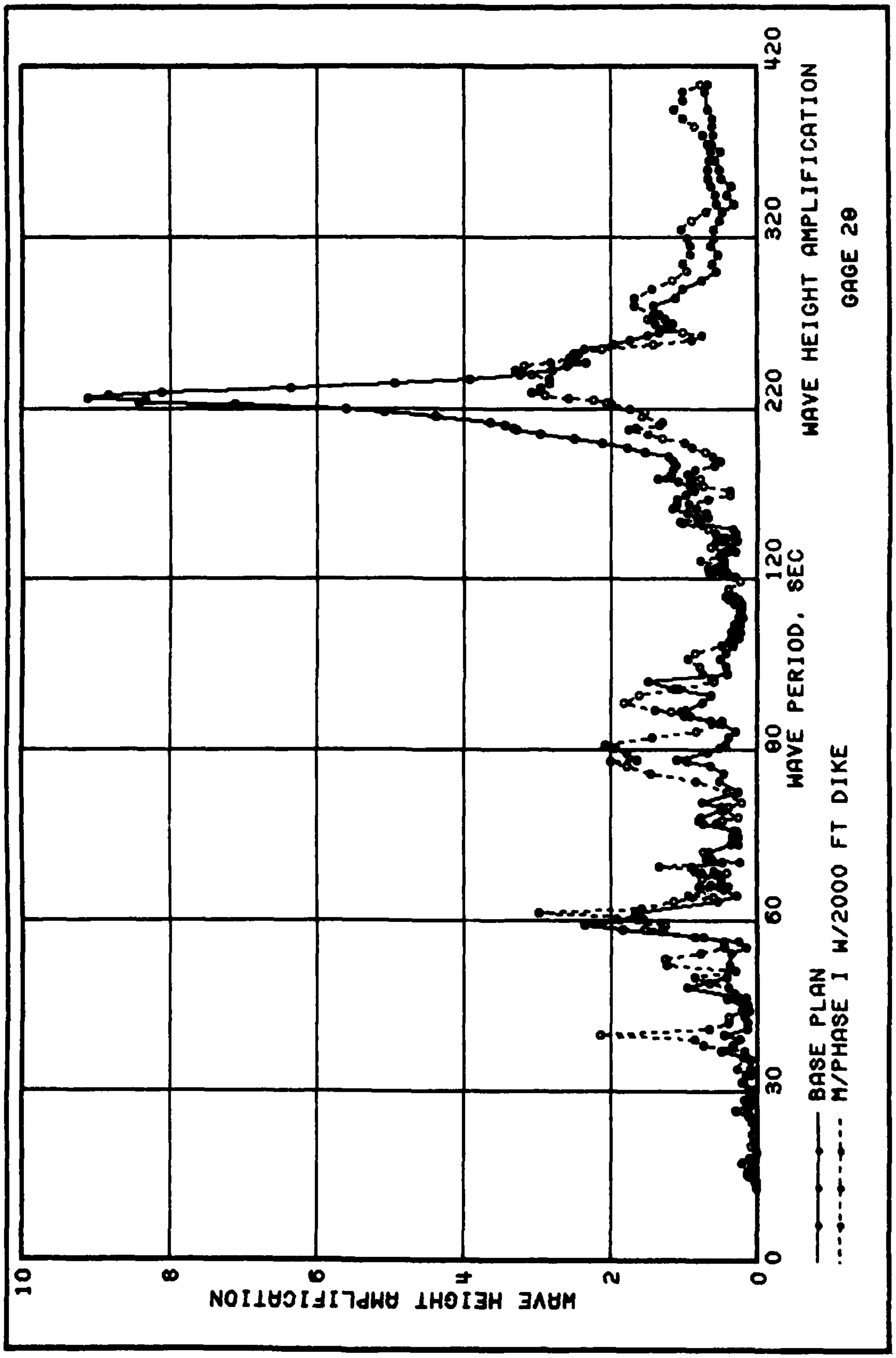

WAVE HEIGHT AMPLIFICATION
GAGE 28
WAVE HEIGHT AMPLIFICATION
WAVE PERIOD, SEC
0
30
60
90
120
220
320
420
0
1
2
3
4
5
BASE PLAN
M/PHASE I W/2000 FT DIKE

PLATE 30



WAVE HEIGHT AMPLIFICATION
GAGE 20
WAVE PERIOD, SEC
WAVE HEIGHT AMPLIFICATION
BASE PLAN
W/PHASE I W/2000 FT DIKE
0
30
60
90
120
220
320
420
0
2
4
6
8
10

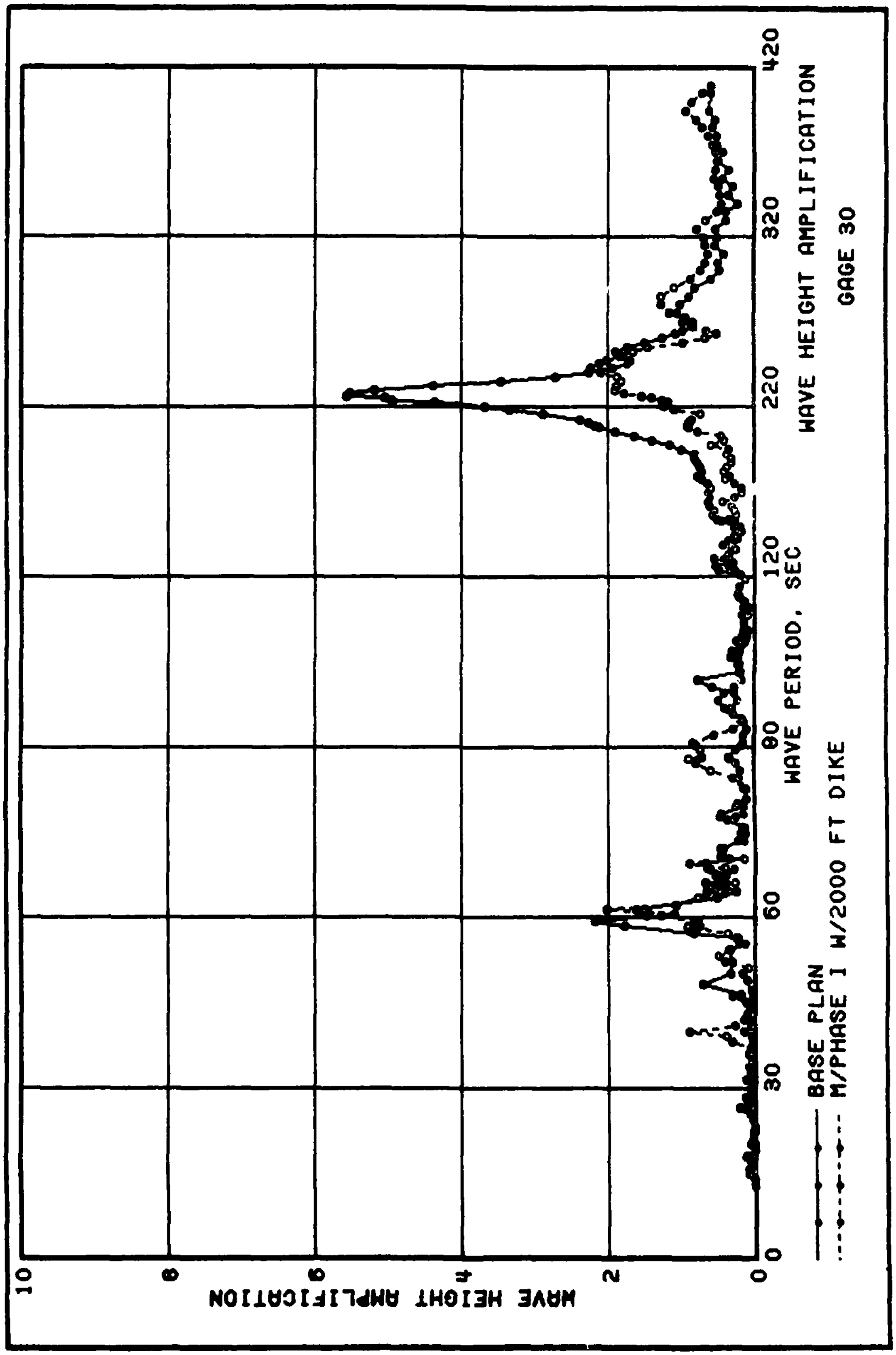

WAVE HEIGHT AMPLIFICATION
GAGE 30
WAVE PERIOD, SEC
WAVE HEIGHT AMPLIFICATION
BASE PLAN
W/PHASE I W/2000 FT DIKE
0
30
60
90
120
220
320
420
0
2
4
6
8
10

PLATE 32

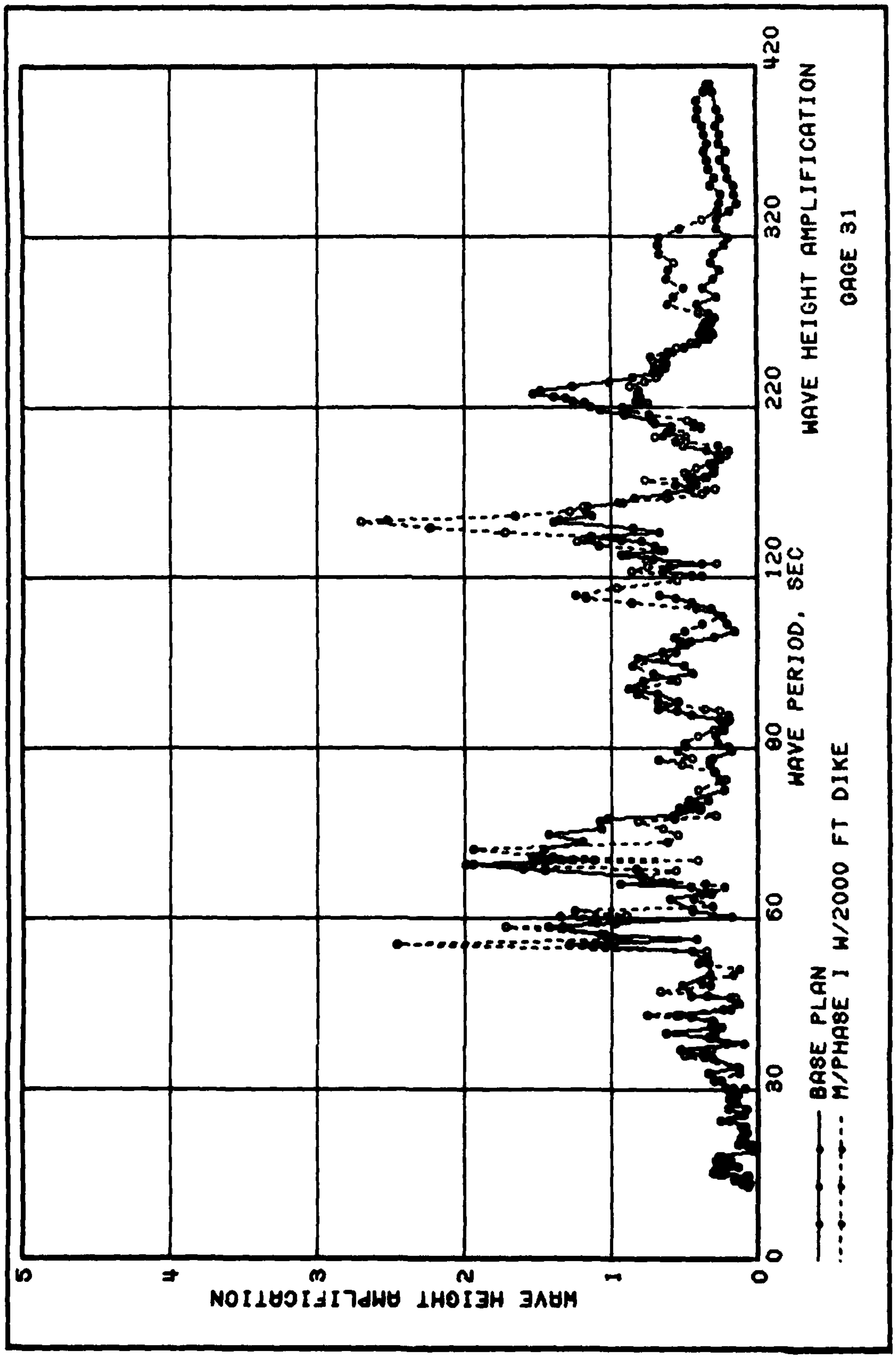

WAVE HEIGHT AMPLIFICATION
GAGE 31
WAVE HEIGHT AMPLIFICATION
WAVE PERIOD, SEC
BASE PLAN
W/PHASE I W/2000 FT DIKE
0
1
2
3
4
5
0
30
60
90
120
220
320
420

PLATE 33

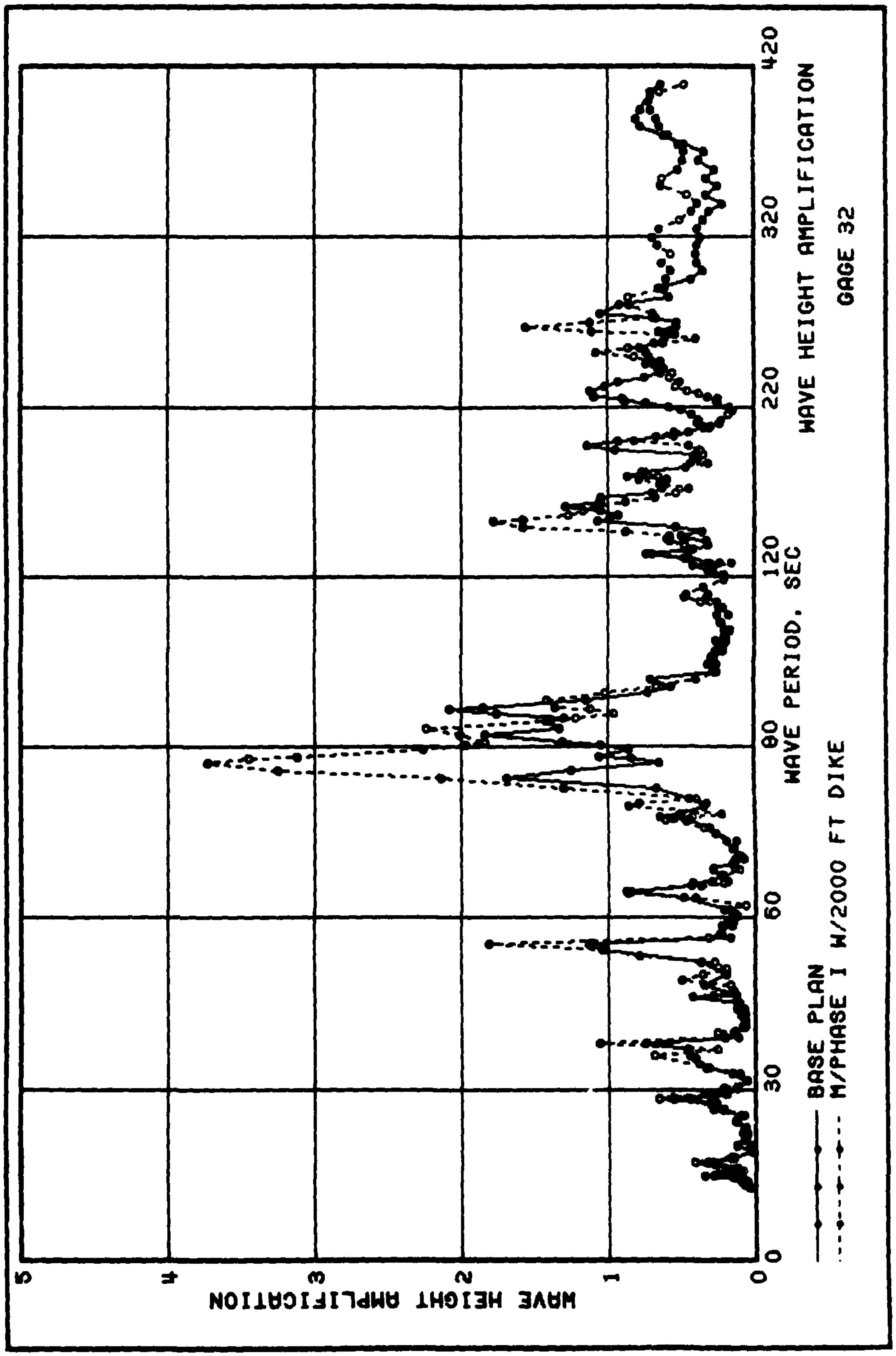
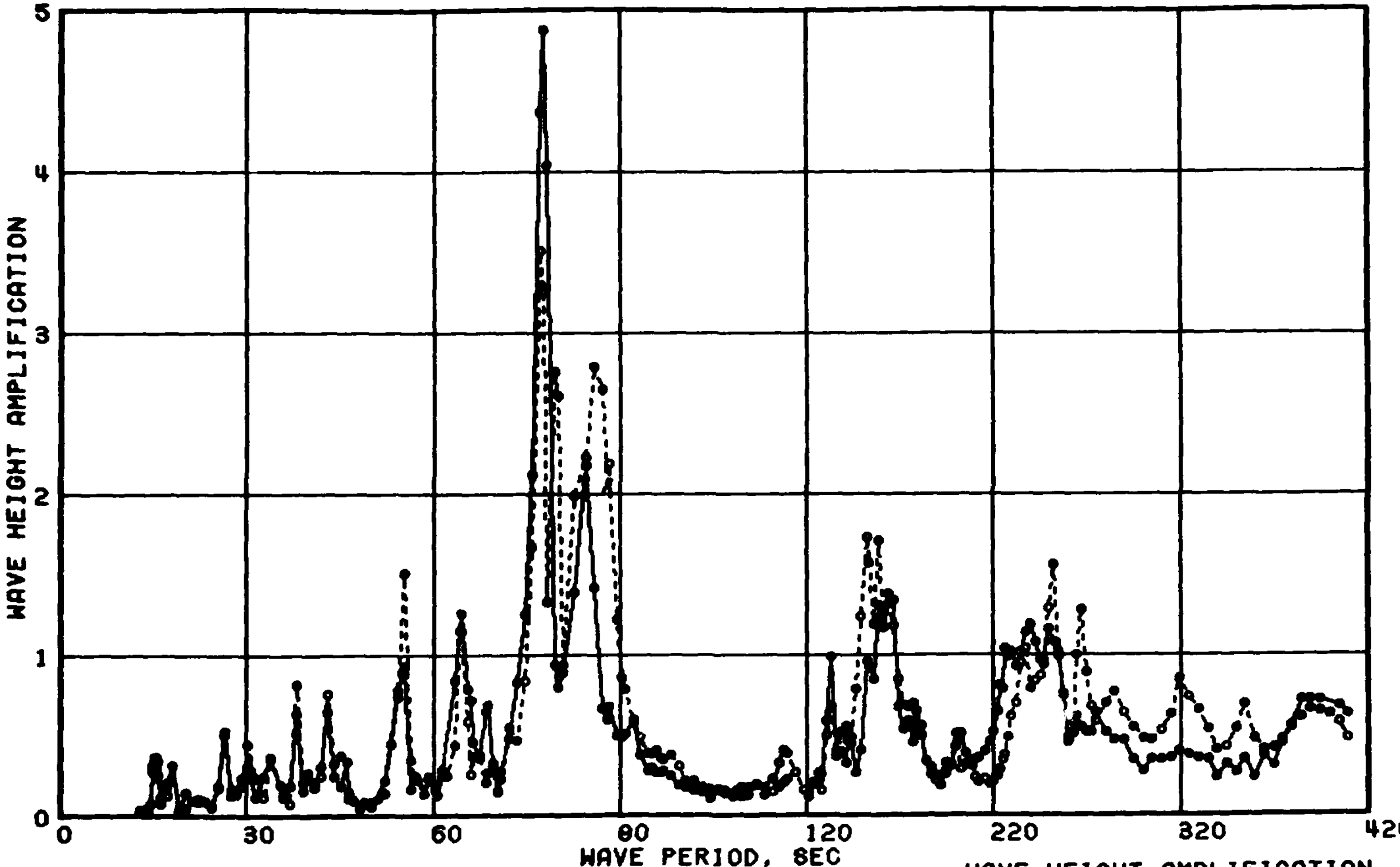

WAVE HEIGHT AMPLIFICATION
GAGE 32
WAVE PERIOD, SEC
WAVE HEIGHT AMPLIFICATION
BASE PLAN
W/PHASE I W/2000 FT DIKE
0
30
60
80
120
220
320
420
0
1
2
3
4
5

PLATE 34



BASE PLAN
M/PHASE I W/2000 FT DIKE

WAVE HEIGHT AMPLIFICATION

GAGE 33

PLATE 35

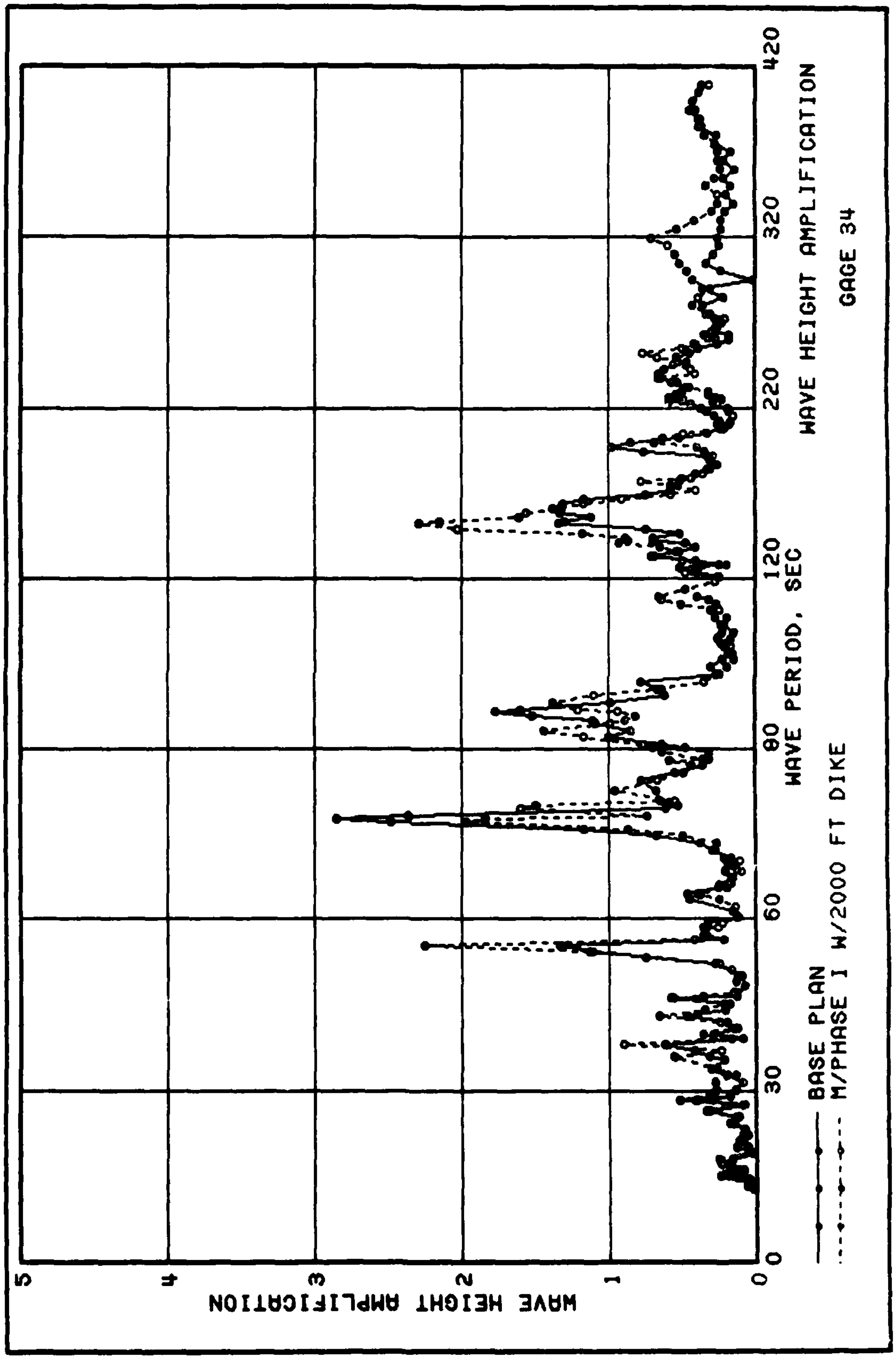
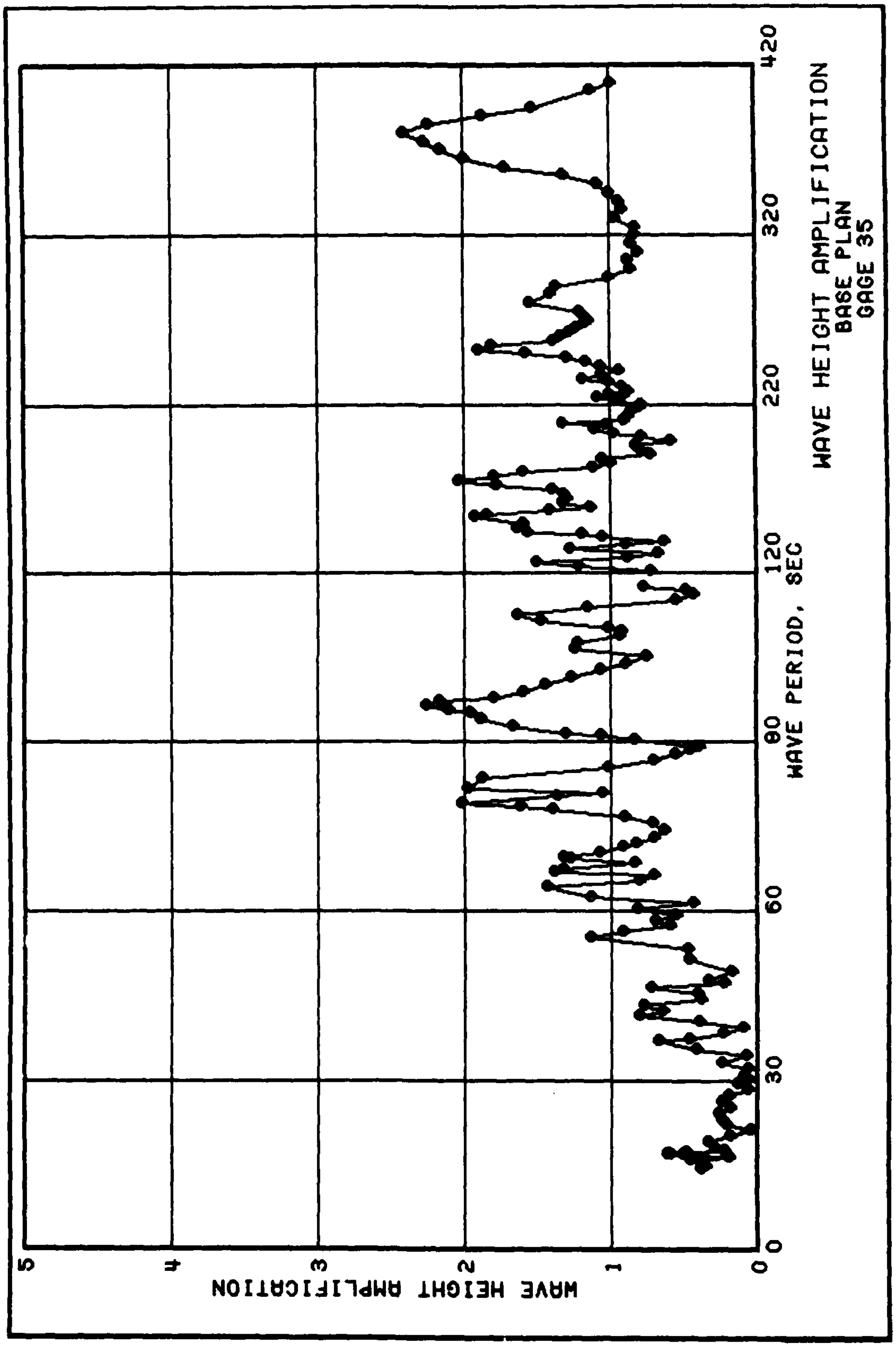

WAVE HEIGHT AMPLIFICATION
GAGE 34
WAVE PERIOD, SEC
WAVE HEIGHT AMPLIFICATION
BASE PLAN
M/PHASE I W/2000 FT DIKE
0
30
60
90
120
220
320
420
0
1
2
3
4
5

PLATE 36


WAVE HEIGHT AMPLIFICATION
BASE PLAN
GAGE 35
WAVE PERIOD, SEC
WAVE HEIGHT AMPLIFICATION
0
30
60
90
120
220
320
420
0
1
2
3
4
5

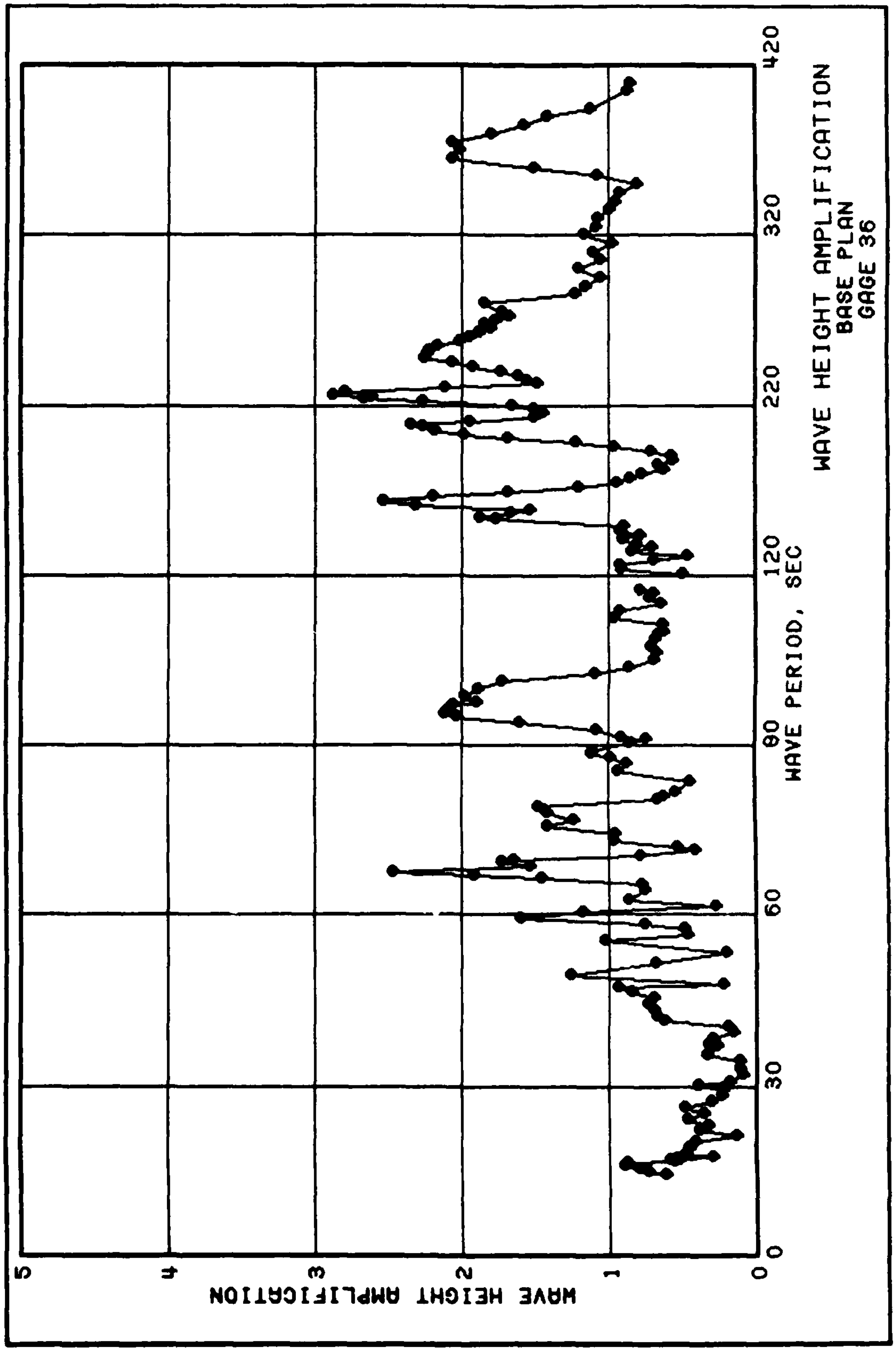
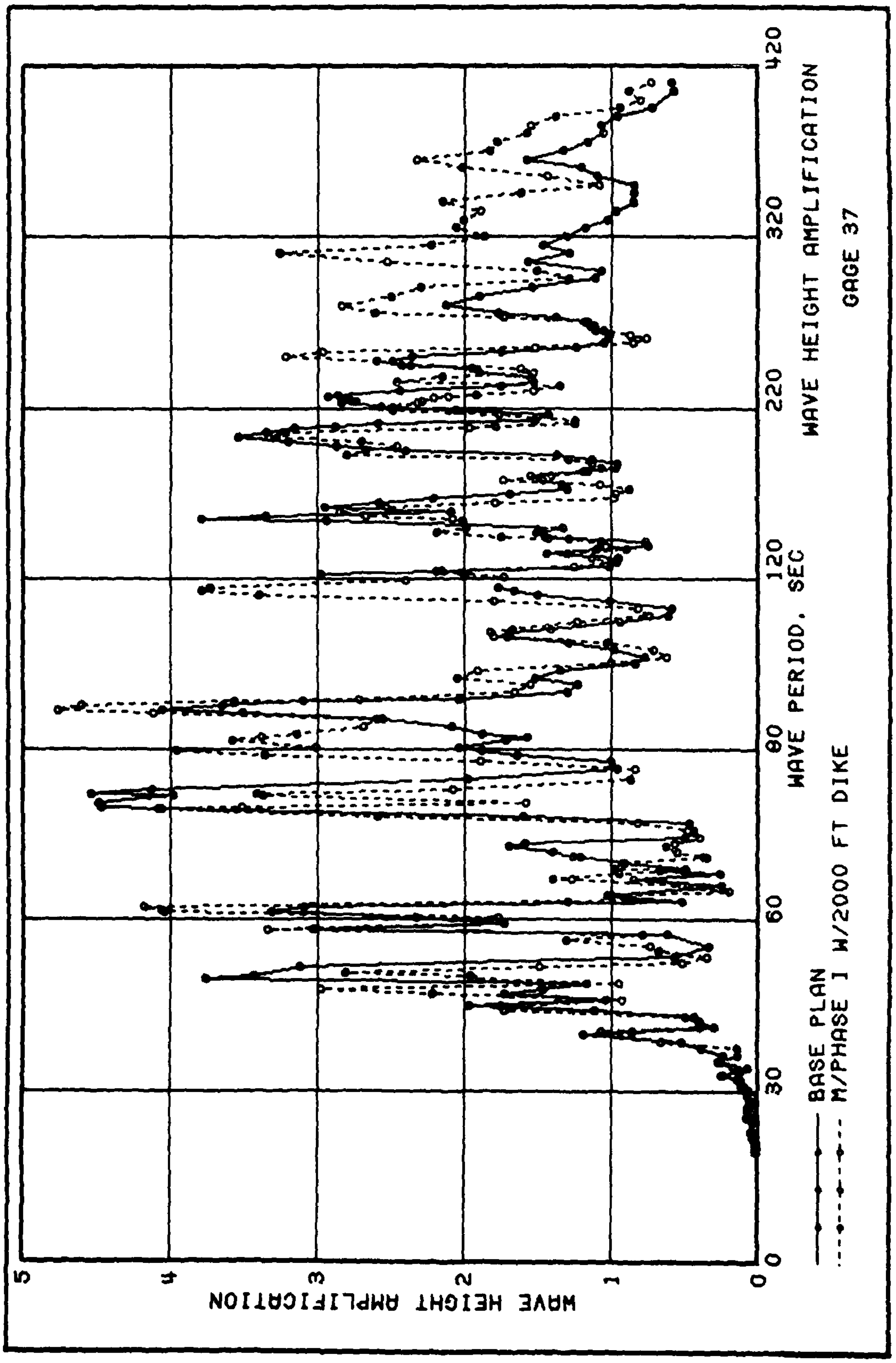

WAVE HEIGHT AMPLIFICATION
BASE PLAN
GAGE 36
WAVE PERIOD, SEC
WAVE HEIGHT AMPLIFICATION
0
30
60
90
120
220
320
420
0
1
2
3
4
5

PLATE 38


WAVE HEIGHT AMPLIFICATION
GAGE 37
WAVE PERIOD, SEC
WAVE HEIGHT AMPLIFICATION
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30
60
90
120
220
320
420
0
1
2
3
4
5
BASE PLAN
W/PHASE I W/2000 FT DIKE

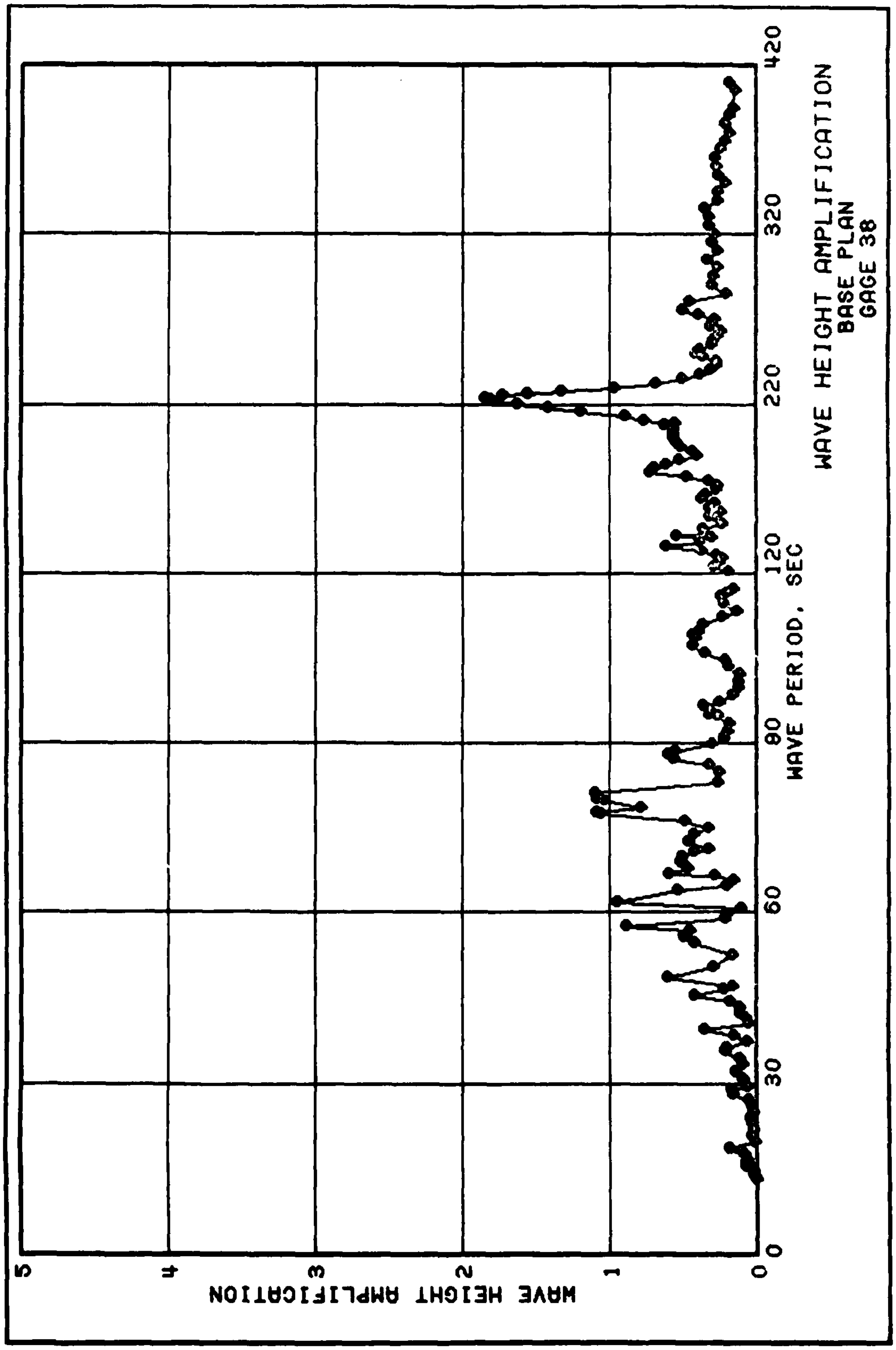
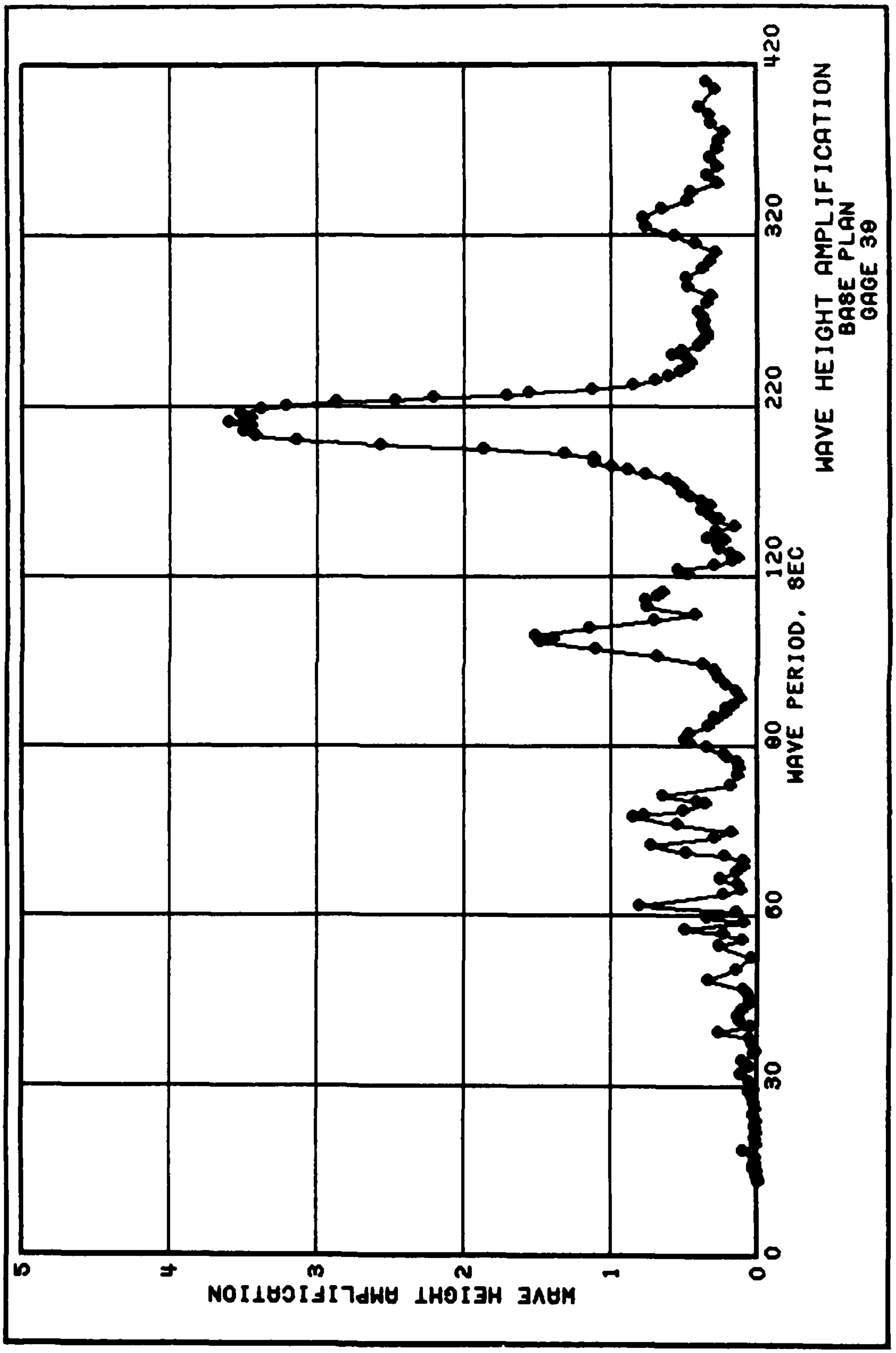

WAVE HEIGHT AMPLIFICATION
BASE PLAN
GAGE 38
WAVE PERIOD, SEC
WAVE HEIGHT AMPLIFICATION
0
30
60
90
120
220
320
420
0
1
2
3
4
5

PLATE 40



WAVE HEIGHT AMPLIFICATION
BASE PLAN
GAGE 39
WAVE PERIOD, SEC
WAVE HEIGHT AMPLIFICATION
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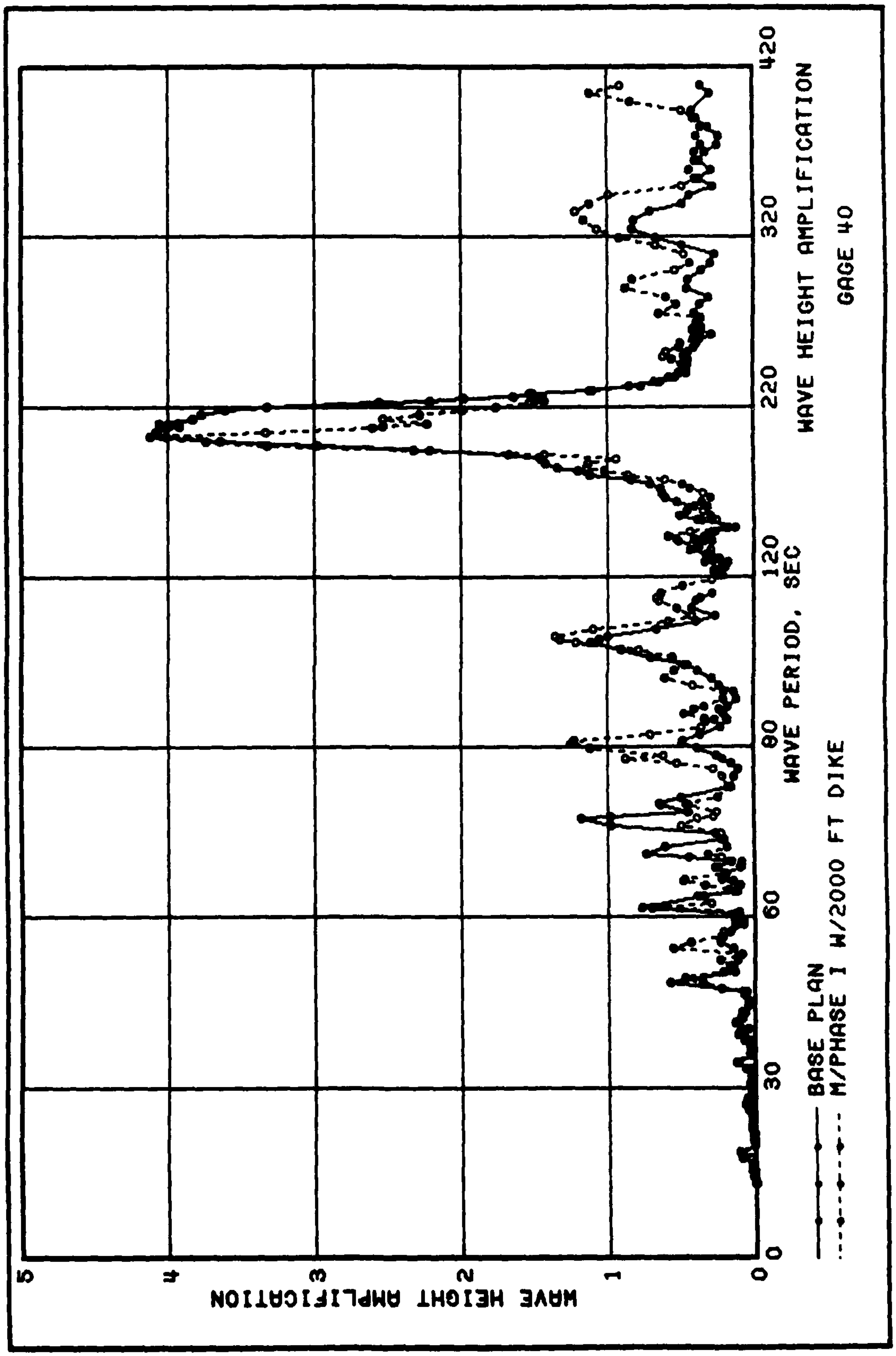
60
90
120
220
320
420
0
1
2
3
4
5

PLATE 41



WAVE HEIGHT AMPLIFICATION
GAGE 40
WAVE HEIGHT AMPLIFICATION
WAVE PERIOD, SEC
0
1
2
3
4
5
0
30
60
90
120
220
320
420
BASE PLAN
W/PHASE I W/2000 FT DIKE

PLATE 42

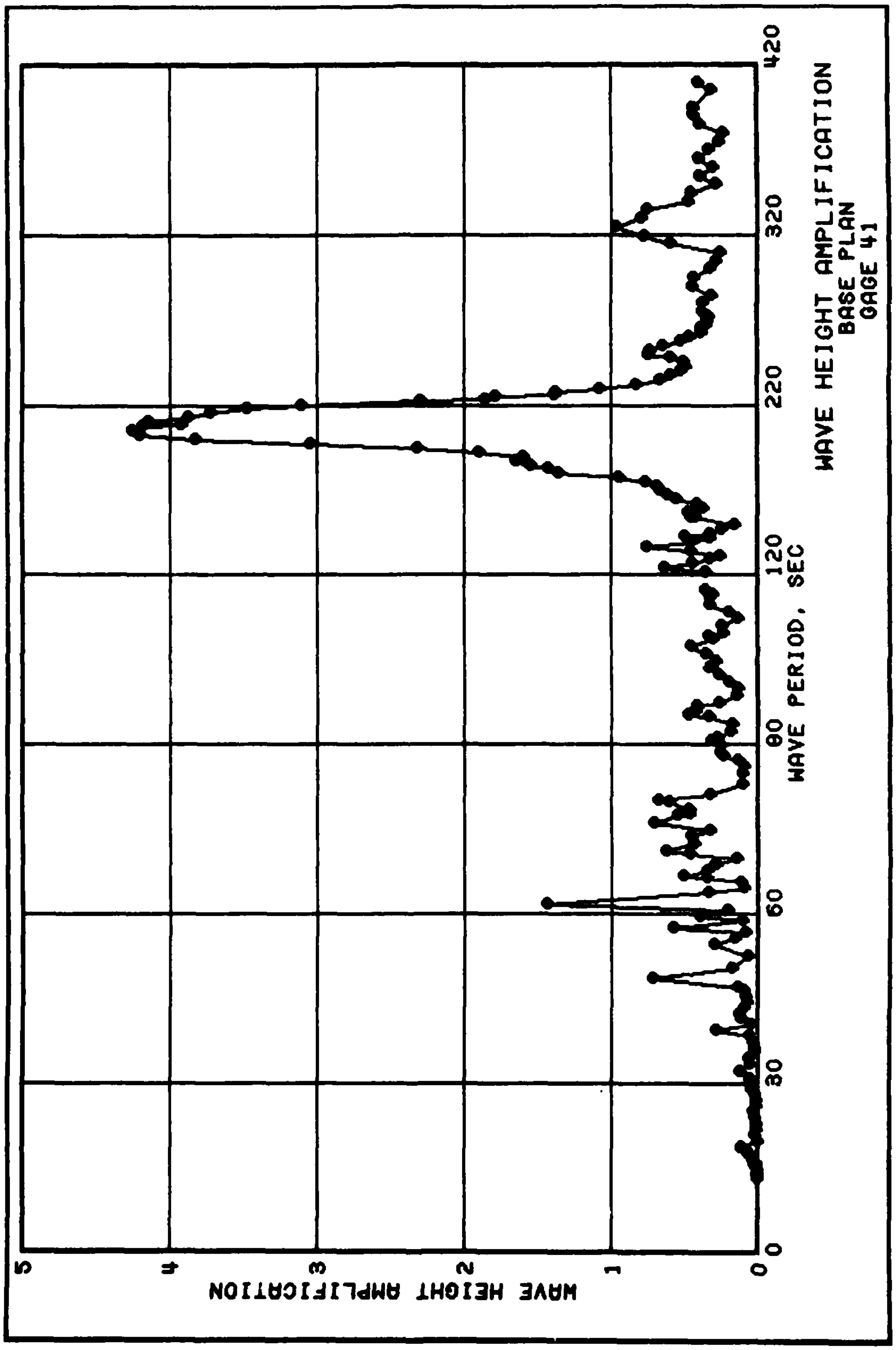
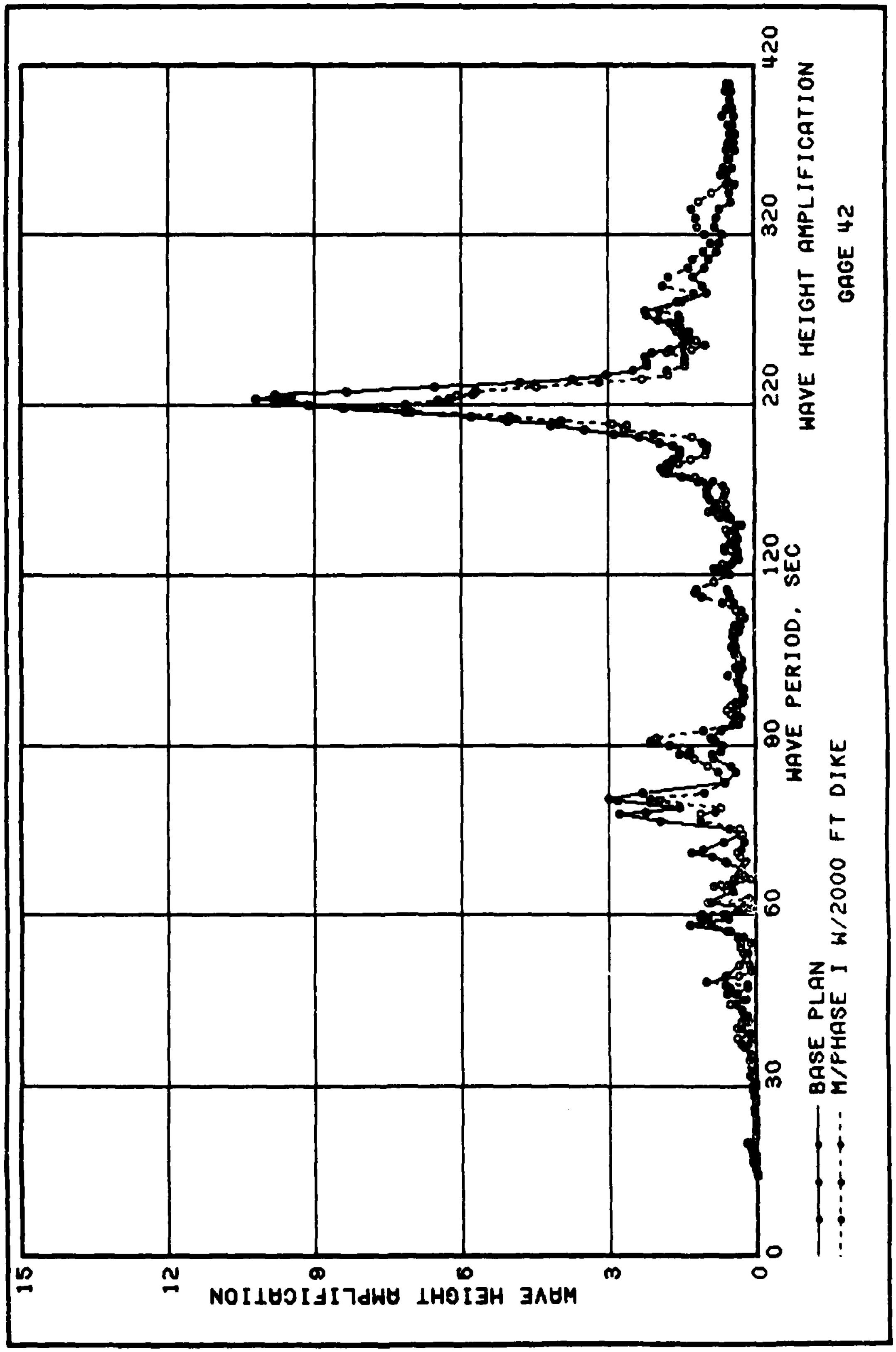
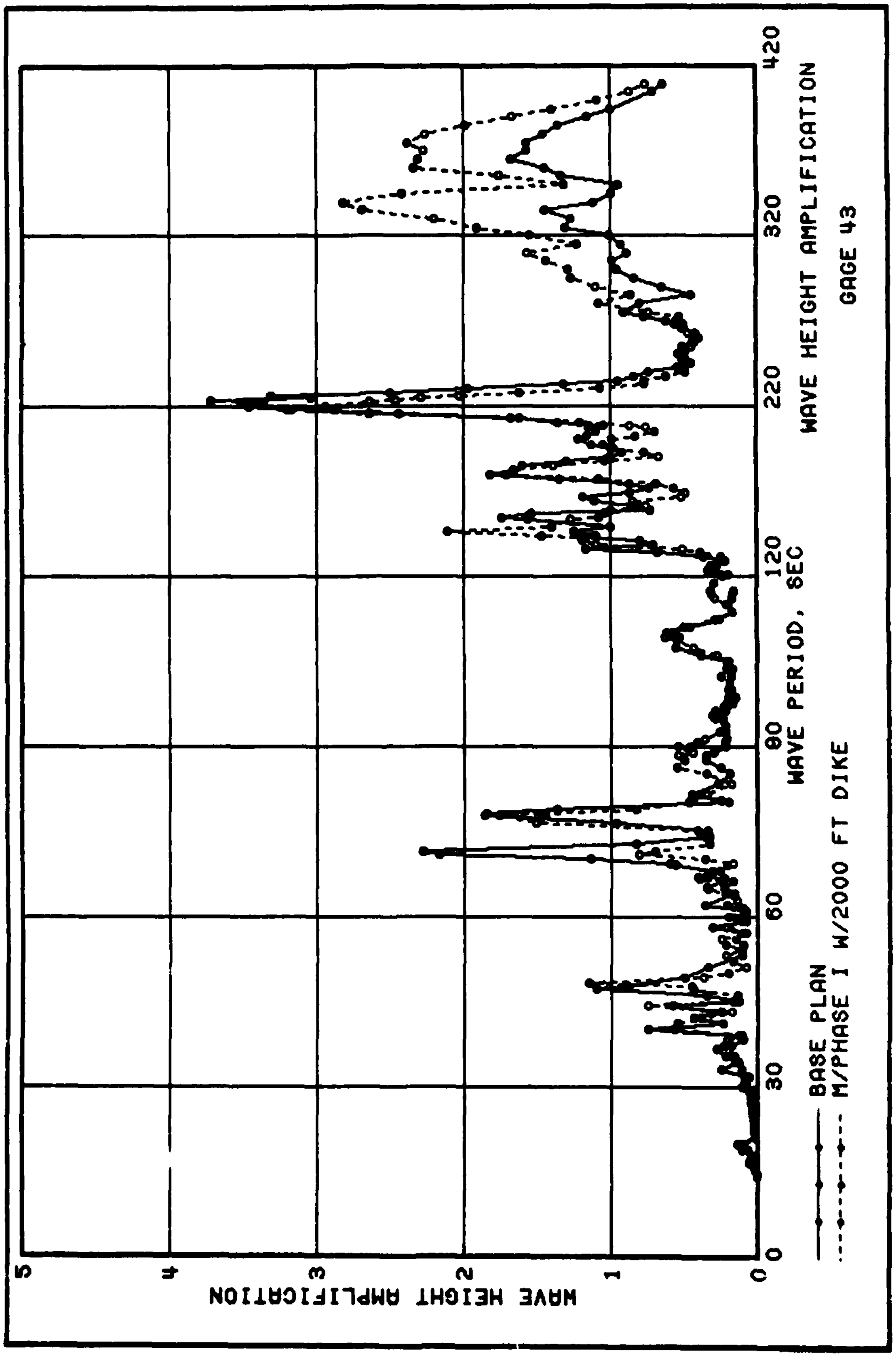

WAVE HEIGHT AMPLIFICATION
BASE PLAN
GAGE 41
WAVE PERIOD, SEC
WAVE HEIGHT AMPLIFICATION
0
1
2
3
4
5
0
30
60
90
120
220
320
420

PLATE 43



WAVE HEIGHT AMPLIFICATION
GAGE 42
WAVE PERIOD, SEC
WAVE HEIGHT AMPLIFICATION
BASE PLAN
M/PHASE I W/2000 FT DIKE
0
30
60
90
120
220
320
420
0
3
6
9
12
15

PLATE 44


WAVE HEIGHT AMPLIFICATION
GAGE 43
WAVE PERIOD, SEC
WAVE HEIGHT AMPLIFICATION
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120
220
320
420
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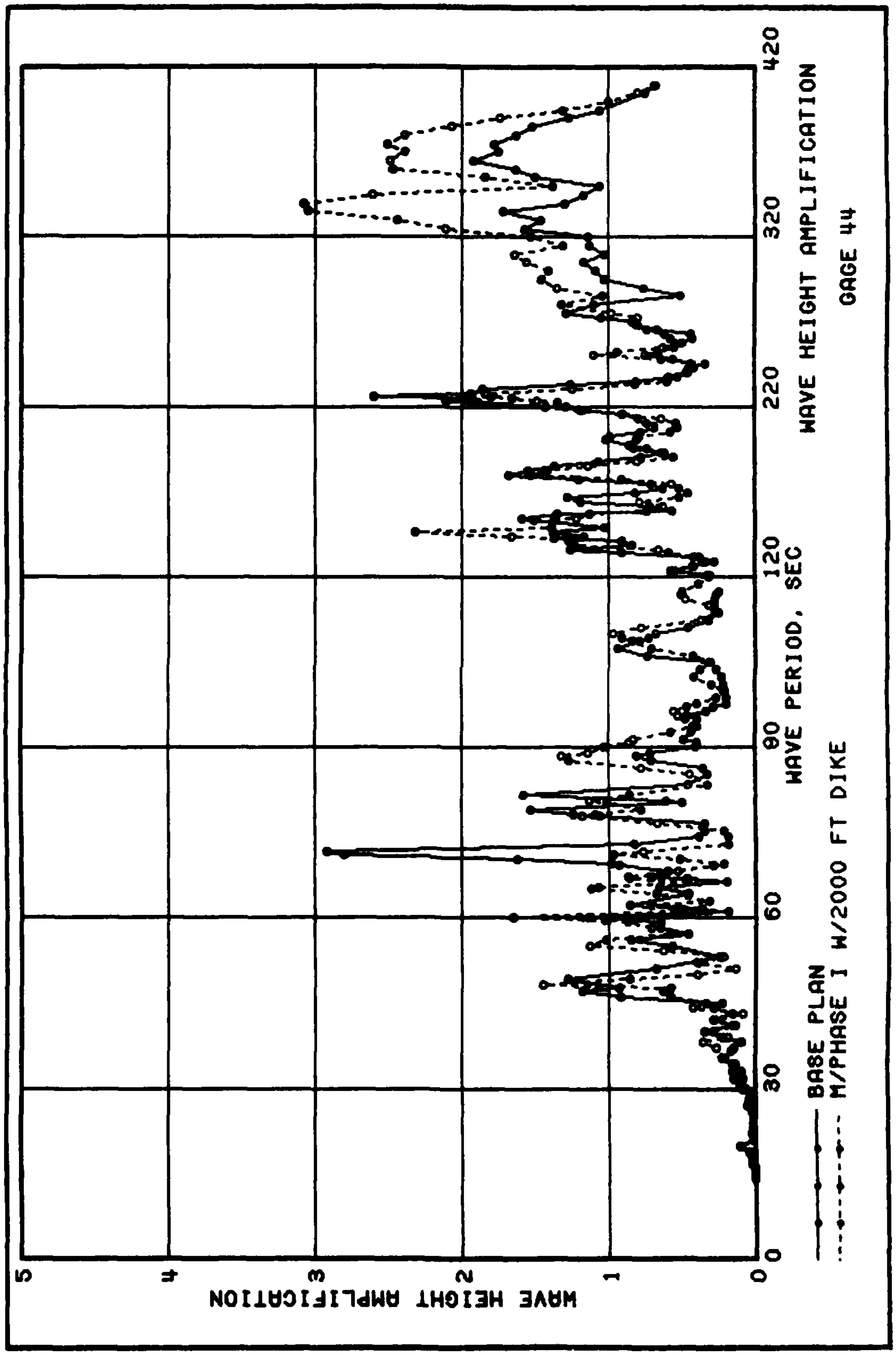
1
2
3
4
5
BASE PLAN
M/PHASE I W/2000 FT DIKE


WAVE HEIGHT AMPLIFICATION
GAGE 44
WAVE PERIOD, SEC
0
30
60
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420
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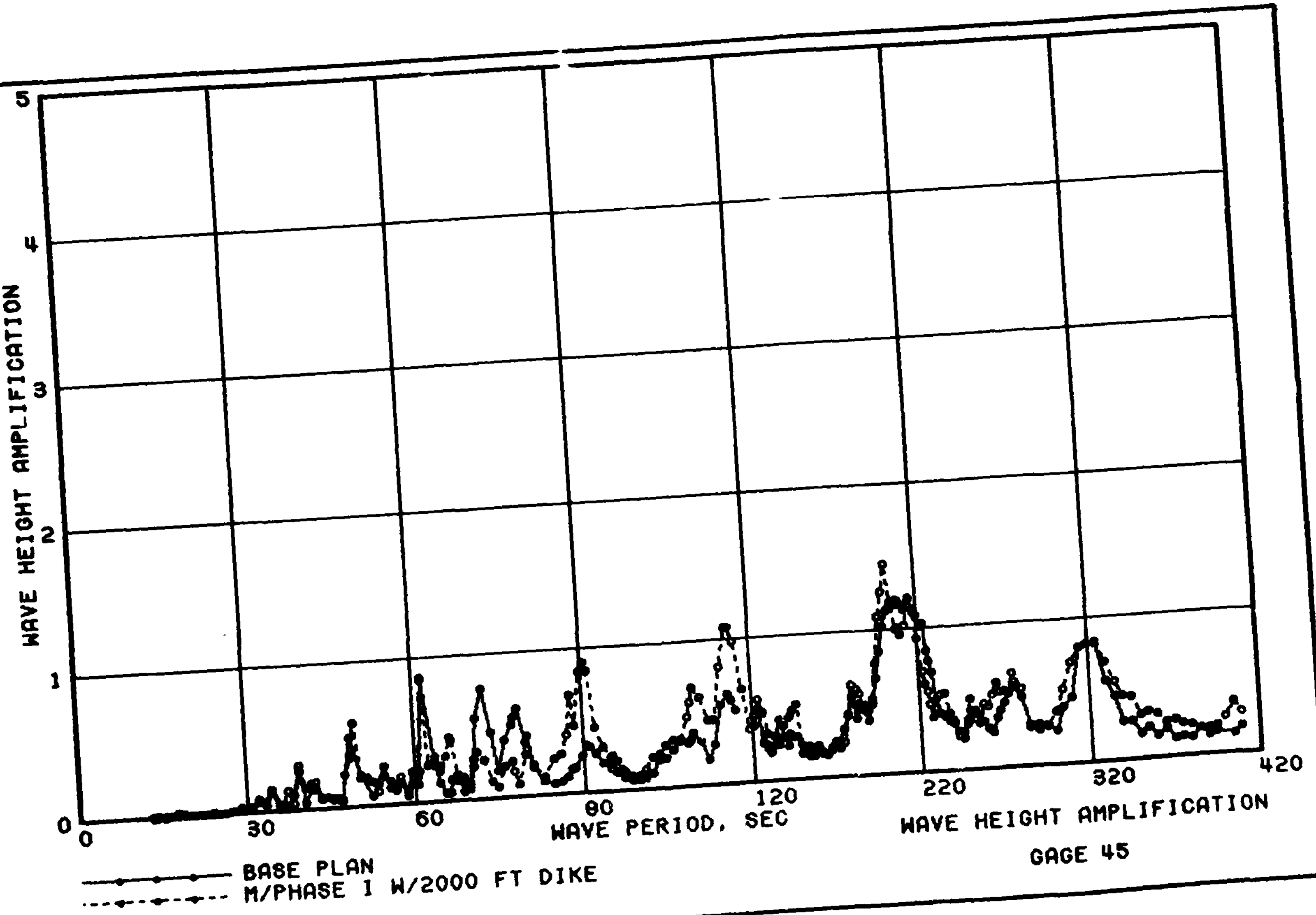
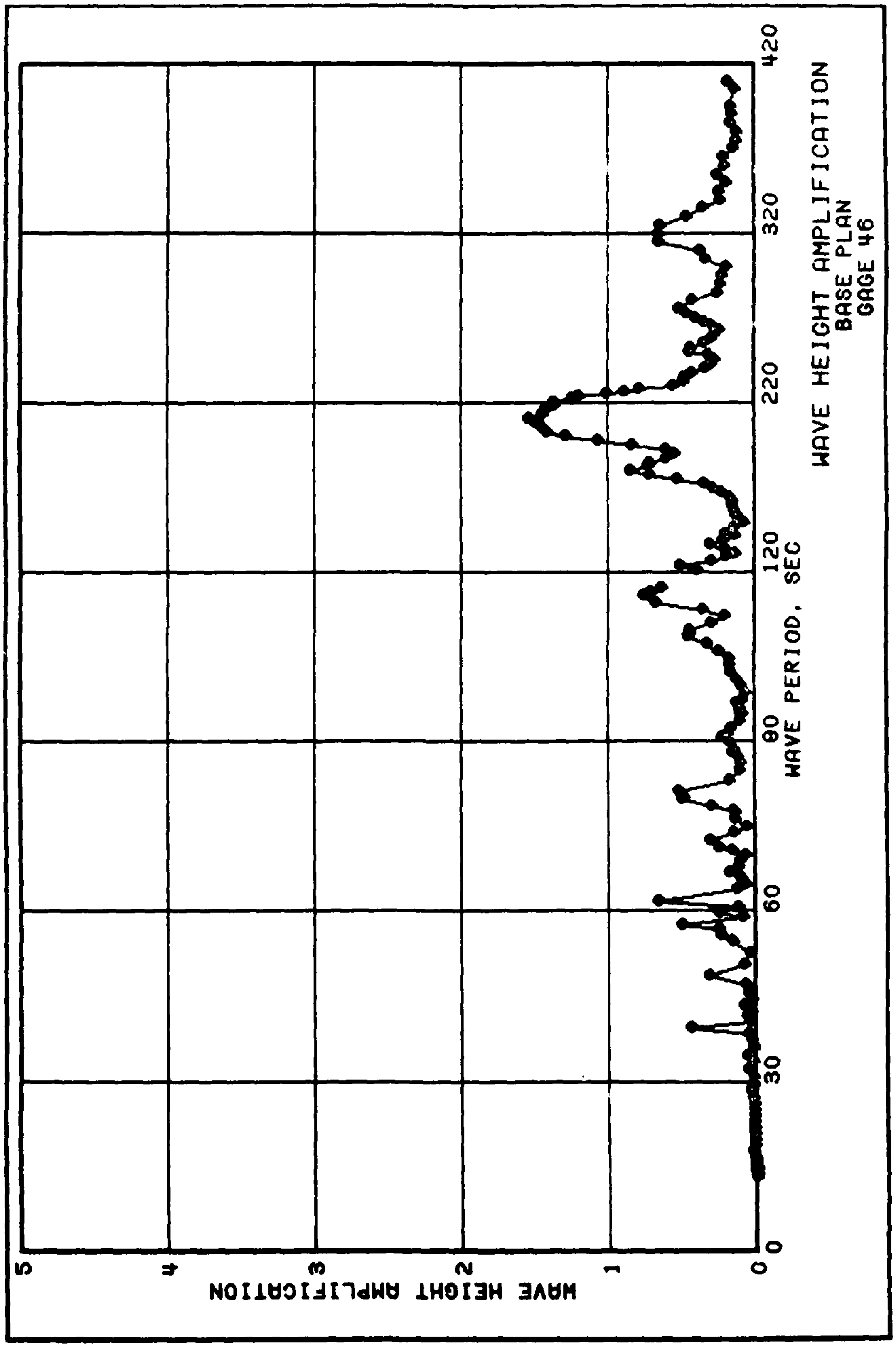
1
2
3
4
5
WAVE HEIGHT AMPLIFICATION
BASE PLAN
M/PHASE I W/2000 FT DIKE



WAVE HEIGHT AMPLIFICATION
GAGE 45


WAVE HEIGHT AMPLIFICATION
BASE PLAN
GAGE 46
WAVE PERIOD, SEC
WAVE HEIGHT AMPLIFICATION
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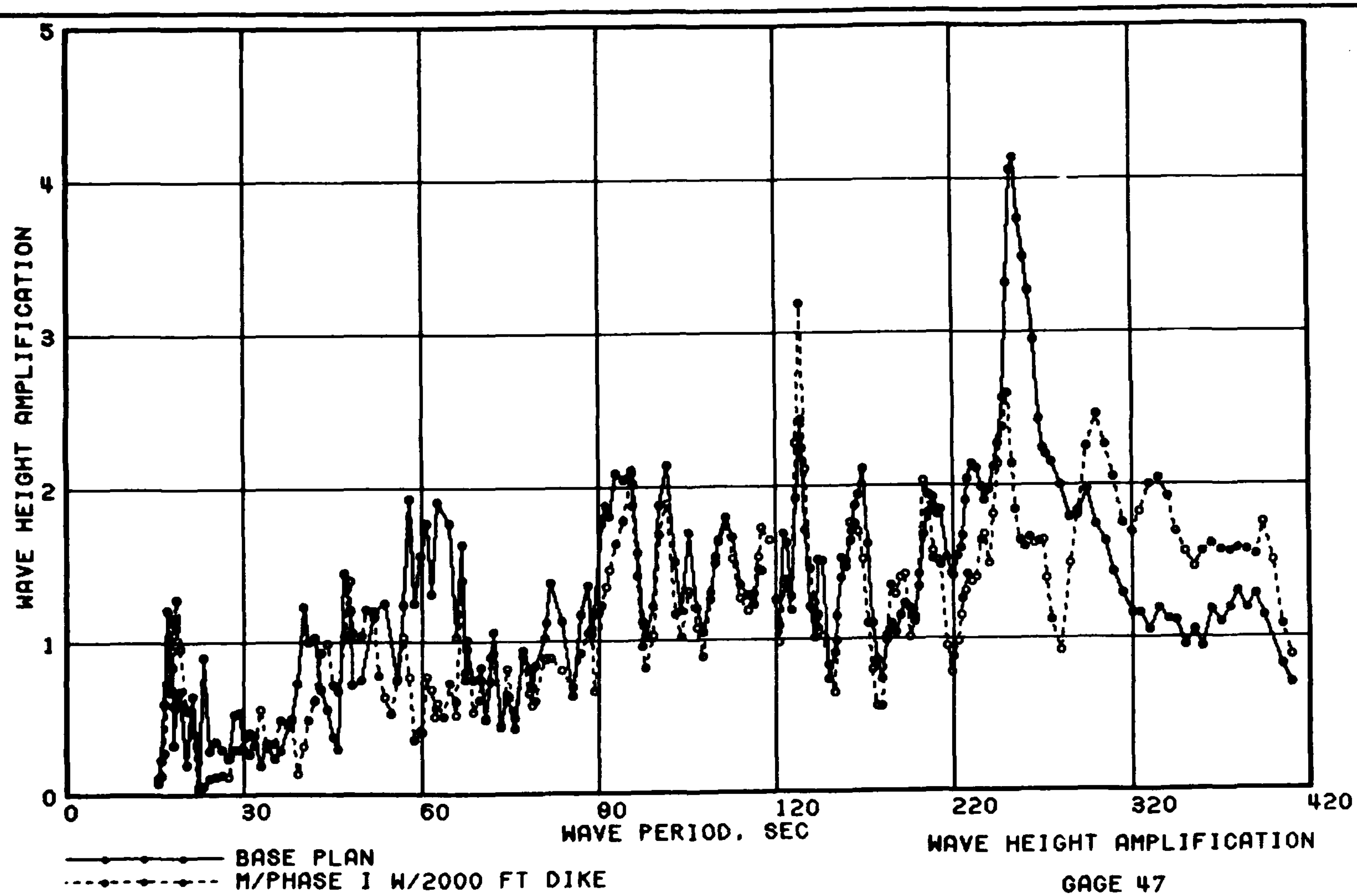
60
90
120
220
320
420
0
1
2
3
4
5

PLATE 48



WAVE HEIGHT AMPLIFICATION

GAGE 47

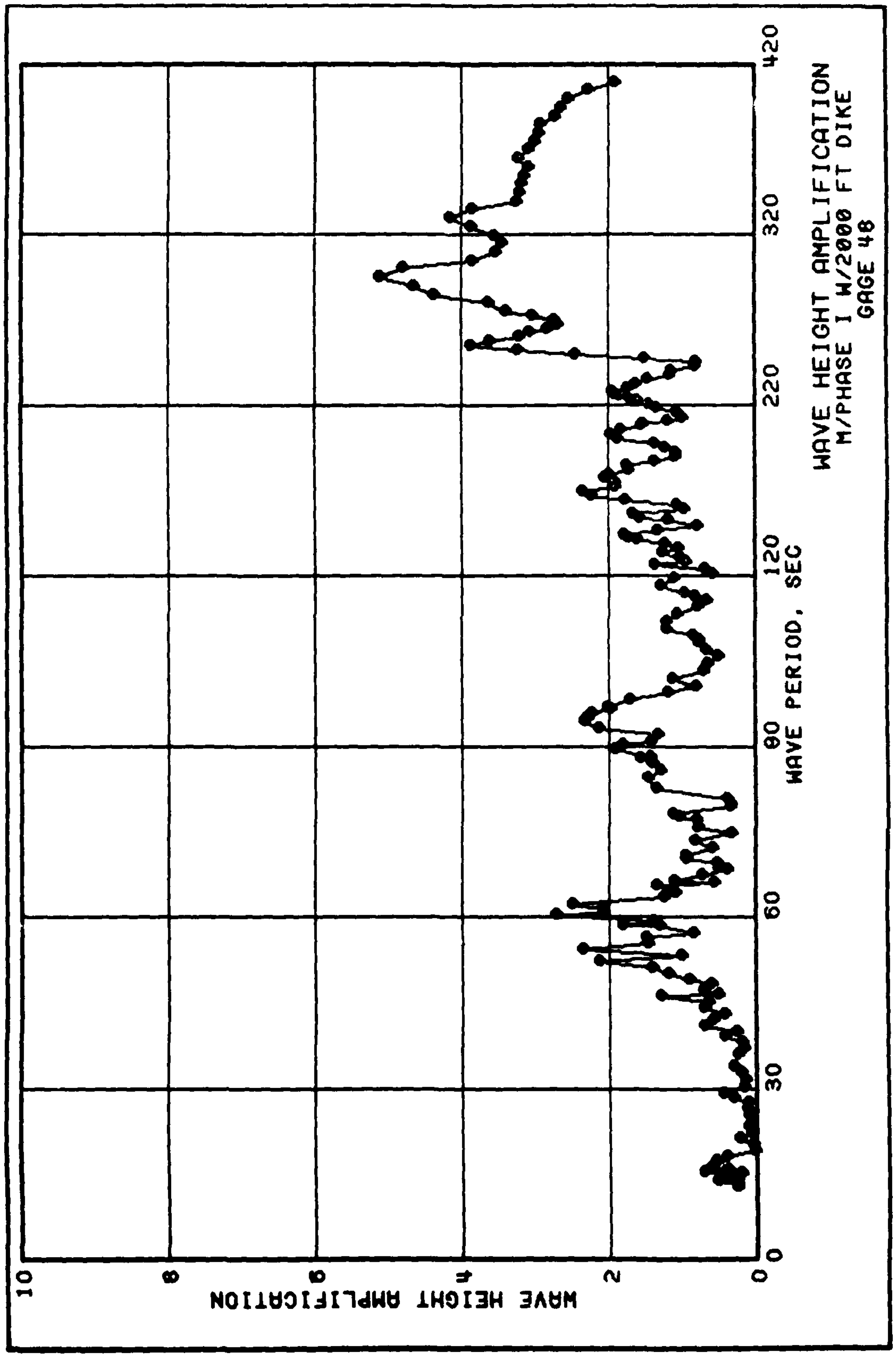

WAVE HEIGHT AMPLIFICATION
M/PHASE I W/2000 FT DIKE
GAGE 48
WAVE PERIOD, SEC
WAVE HEIGHT AMPLIFICATION
0
30
60
90
120
220
320
420
0
2
4
6
8
10

PLATE 50

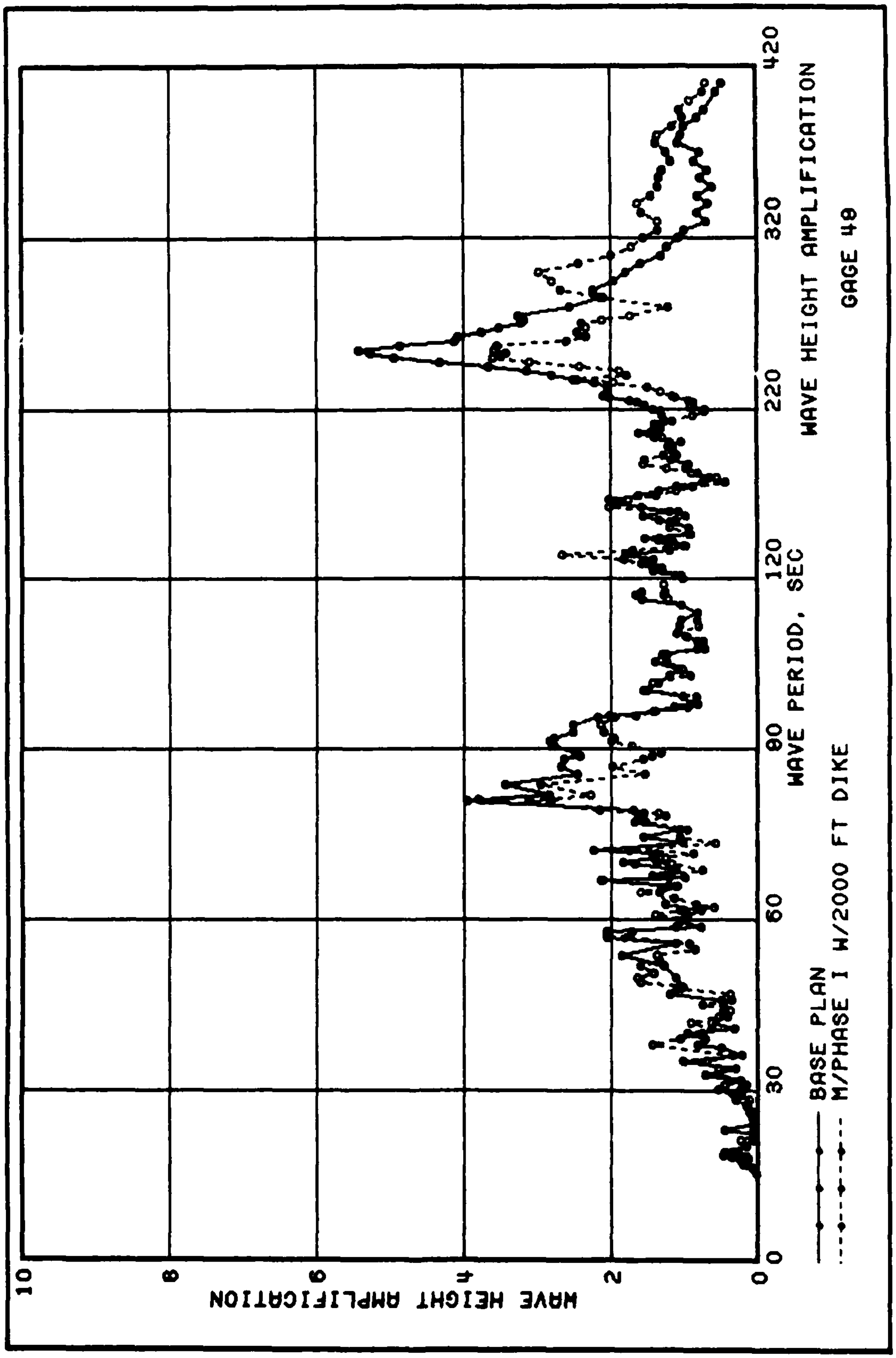
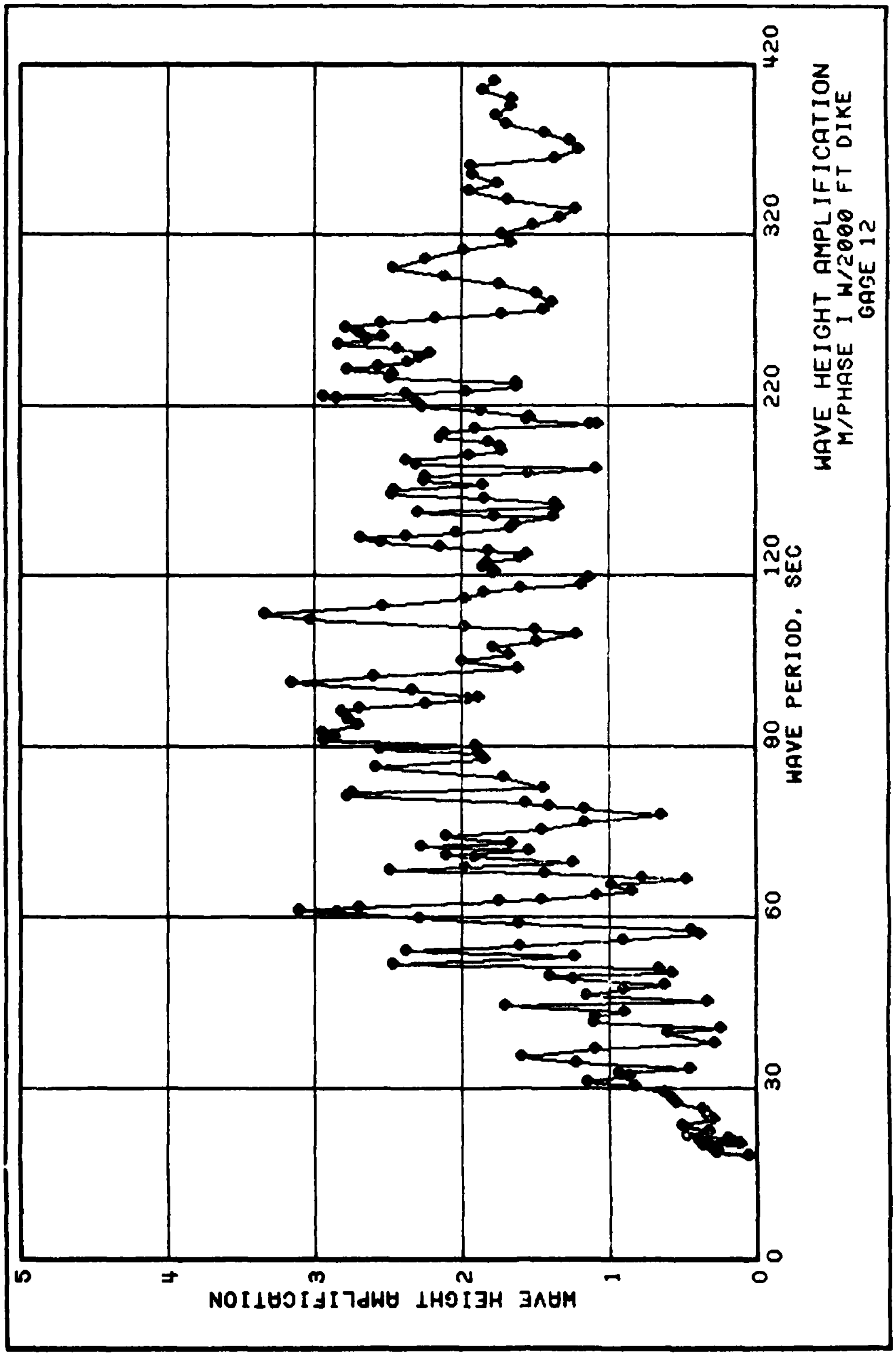

WAVE HEIGHT AMPLIFICATION
GAGE 48
WAVE PERIOD, SEC
WAVE HEIGHT AMPLIFICATION
BASE PLAN
M/PHASE I W/2000 FT DIKE
0
30
60
90
120
220
320
420
0
2
4
6
8
10

PLATE 51


WAVE HEIGHT AMPLIFICATION
M/PHASE 1 W/2000 FT DIKE
GAGE 12
WAVE PERIOD, SEC
WAVE HEIGHT AMPLIFICATION
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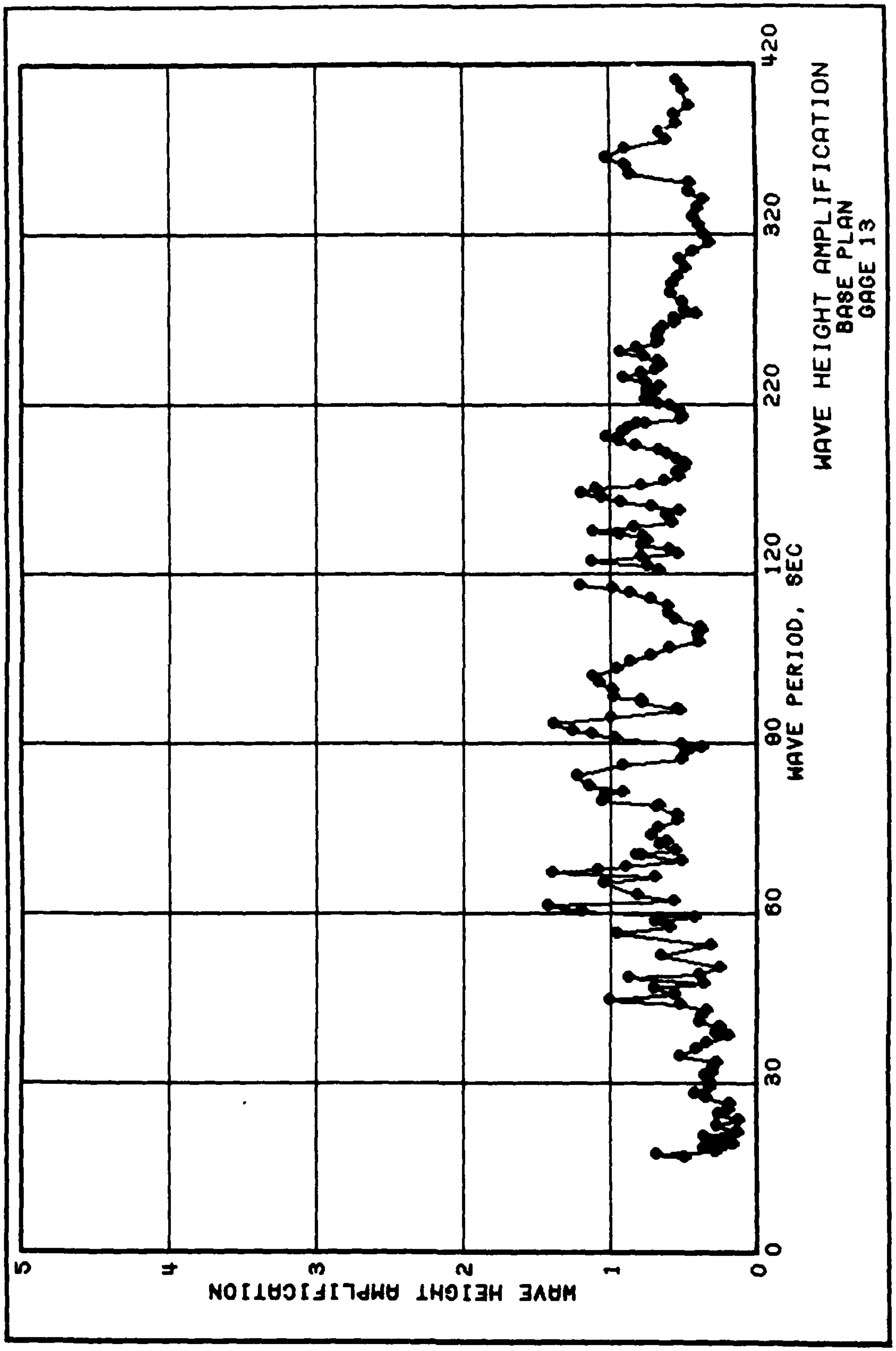
60
90
120
220
320
420
0
1
2
3
4
5

PLATE 52


WAVE HEIGHT AMPLIFICATION
BASE PLAN
GAGE 13
WAVE PERIOD, SEC
WAVE HEIGHT AMPLIFICATION
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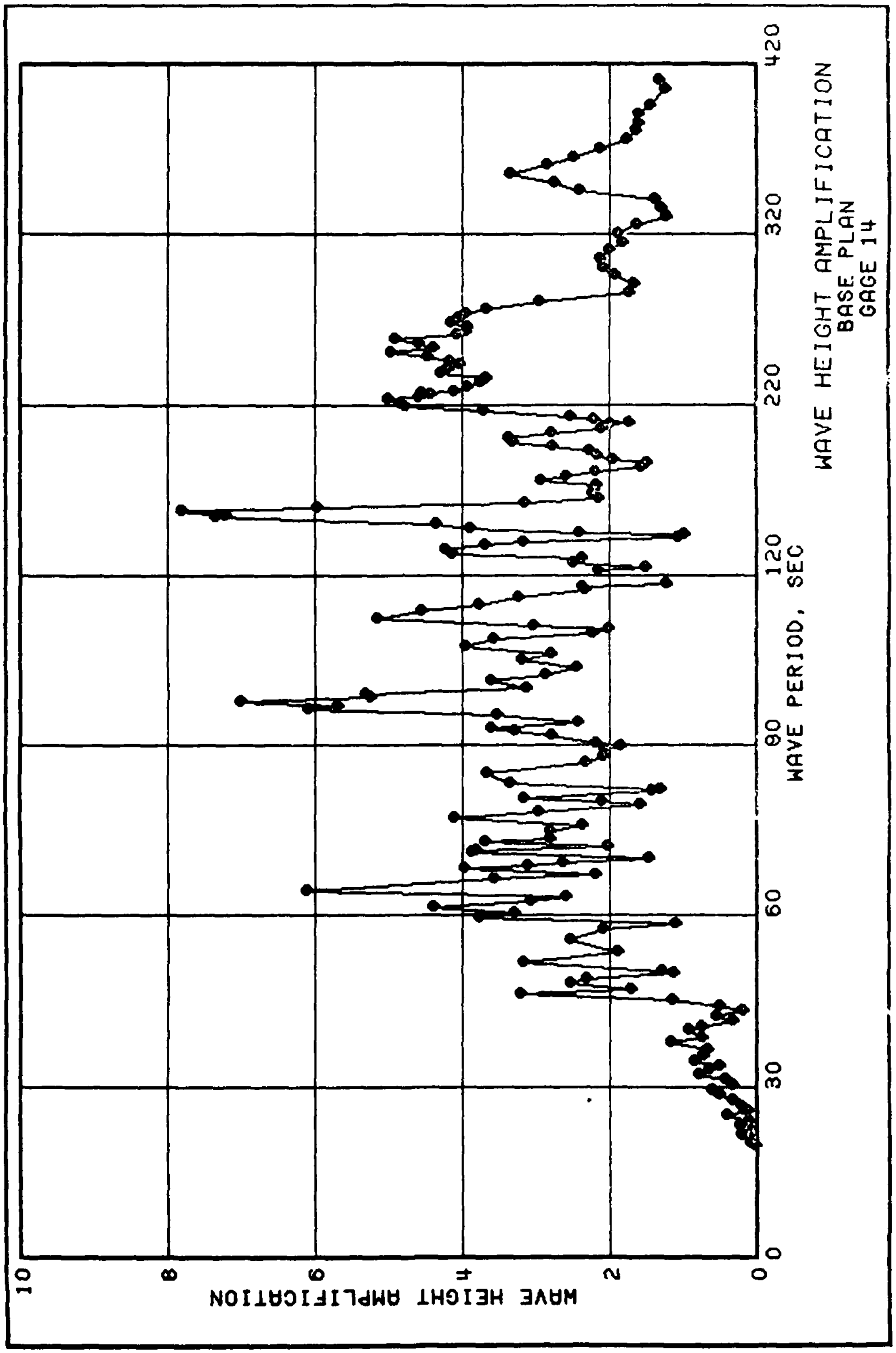
90
120
220
320
420
0
1
2
3
4
5


WAVE HEIGHT AMPLIFICATION
BASE PLAN
GAGE 14
WAVE PERIOD, SEC
WAVE HEIGHT AMPLIFICATION
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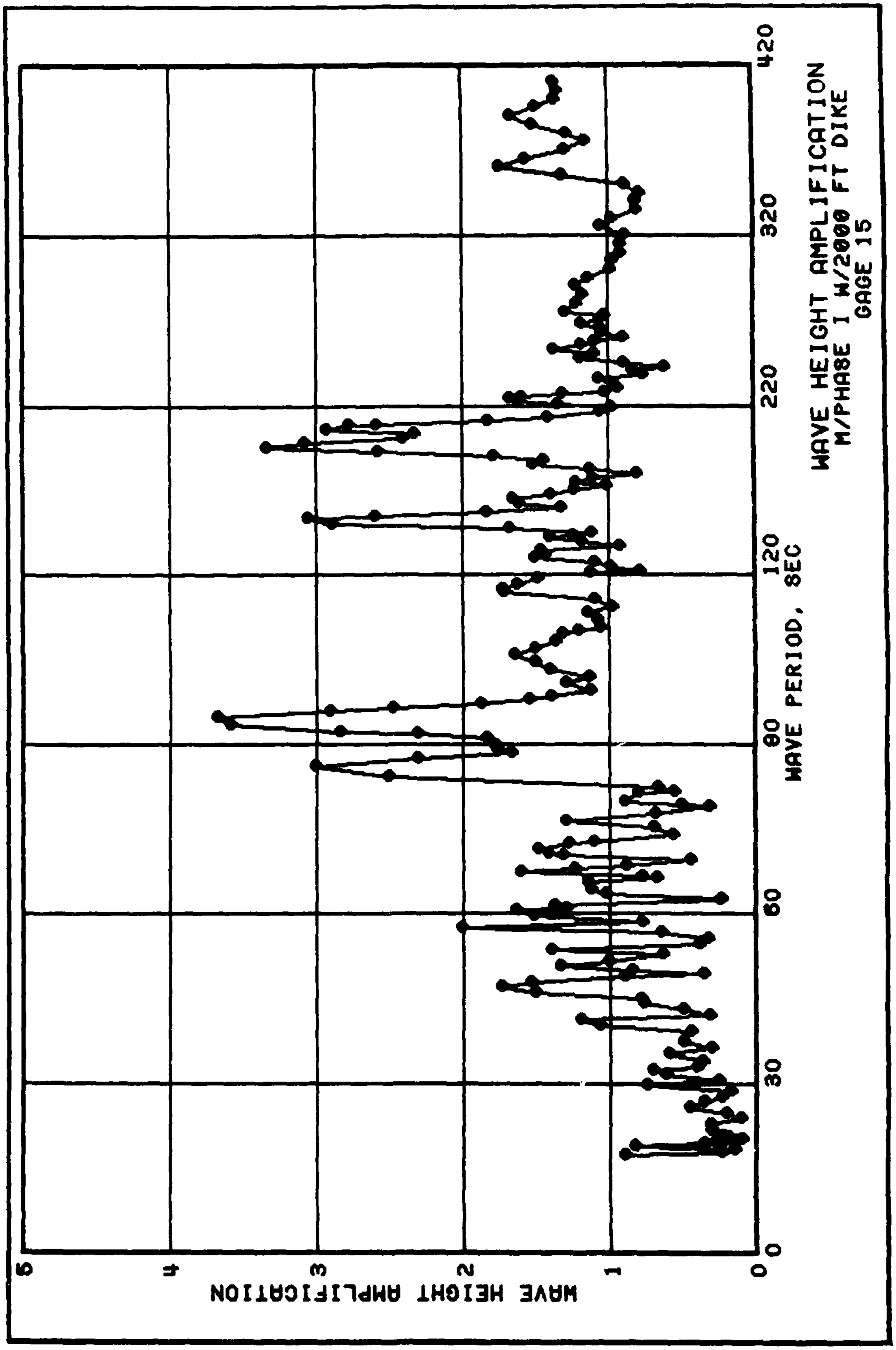
90
120
220
320
420
0
2
4
6
8
10

PLATE 54


WAVE HEIGHT AMPLIFICATION
M/PHASE 1 W/2000 FT DIKE
GAGE 15
WAVE PERIOD, SEC
WAVE HEIGHT AMPLIFICATION
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90
120
220
320
420
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1
2
3
4
5

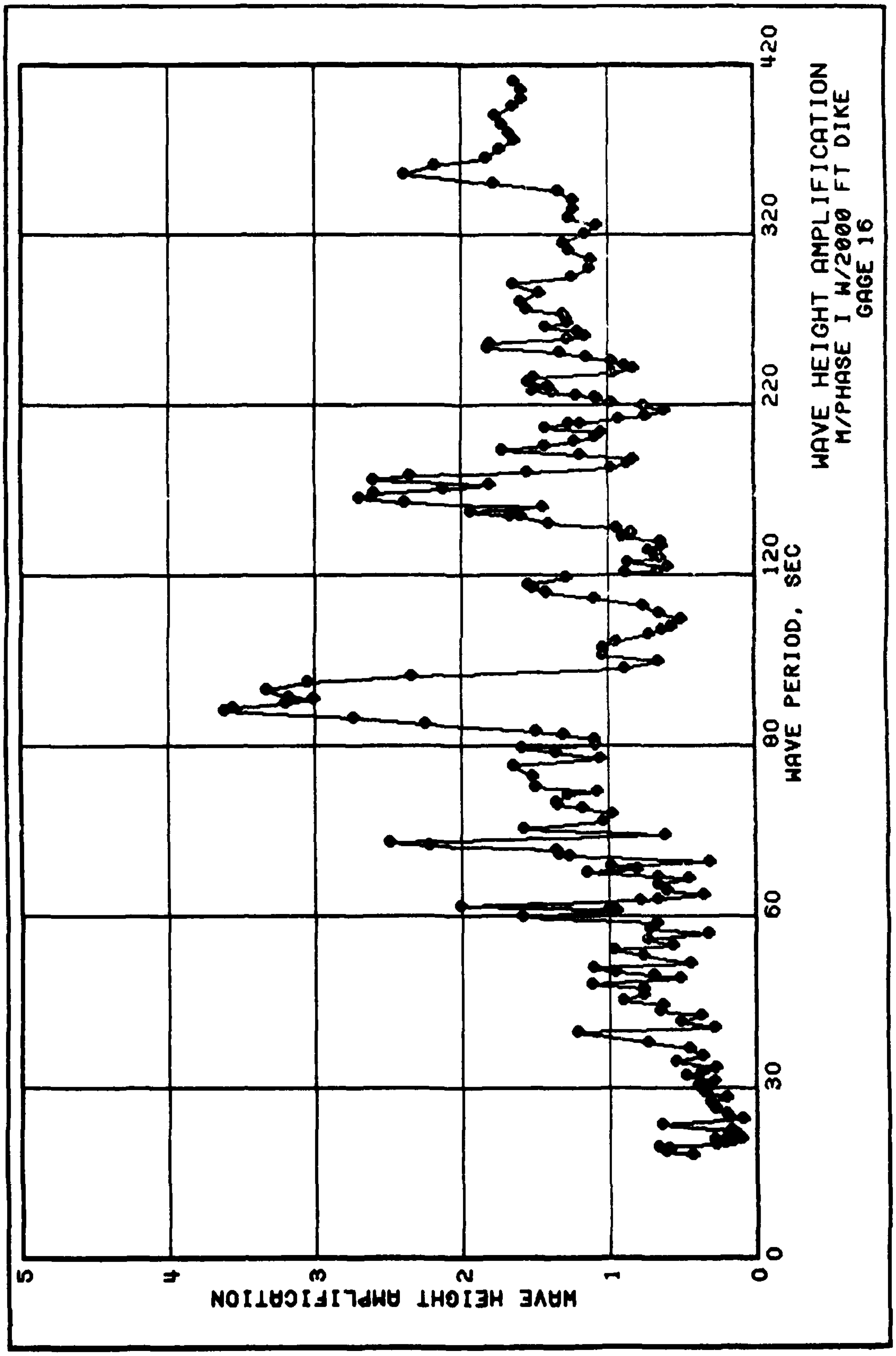
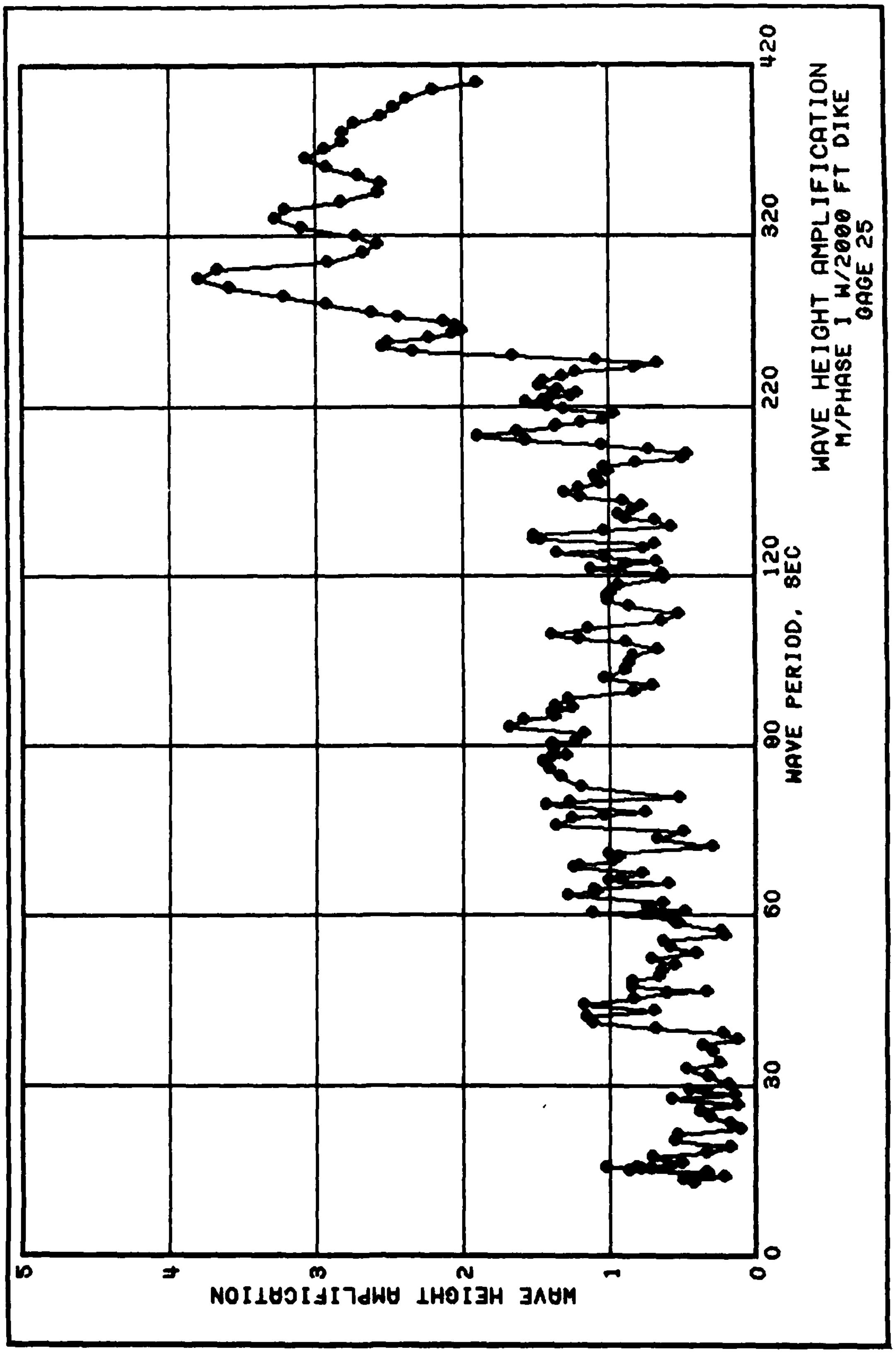

WAVE HEIGHT AMPLIFICATION
M/PHASE I W/2000 FT DIKE
GAGE 16
WAVE PERIOD, SEC
WAVE HEIGHT AMPLIFICATION
0
30
60
90
120
220
320
420
0
1
2
3
4
5

PLATE 56


WAVE HEIGHT AMPLIFICATION
M/PHASE I W/2000 FT DIKE
GAGE 25
WAVE PERIOD, SEC
WAVE HEIGHT AMPLIFICATION
0
30
60
90
120
220
320
420
0
1
2
3
4
5

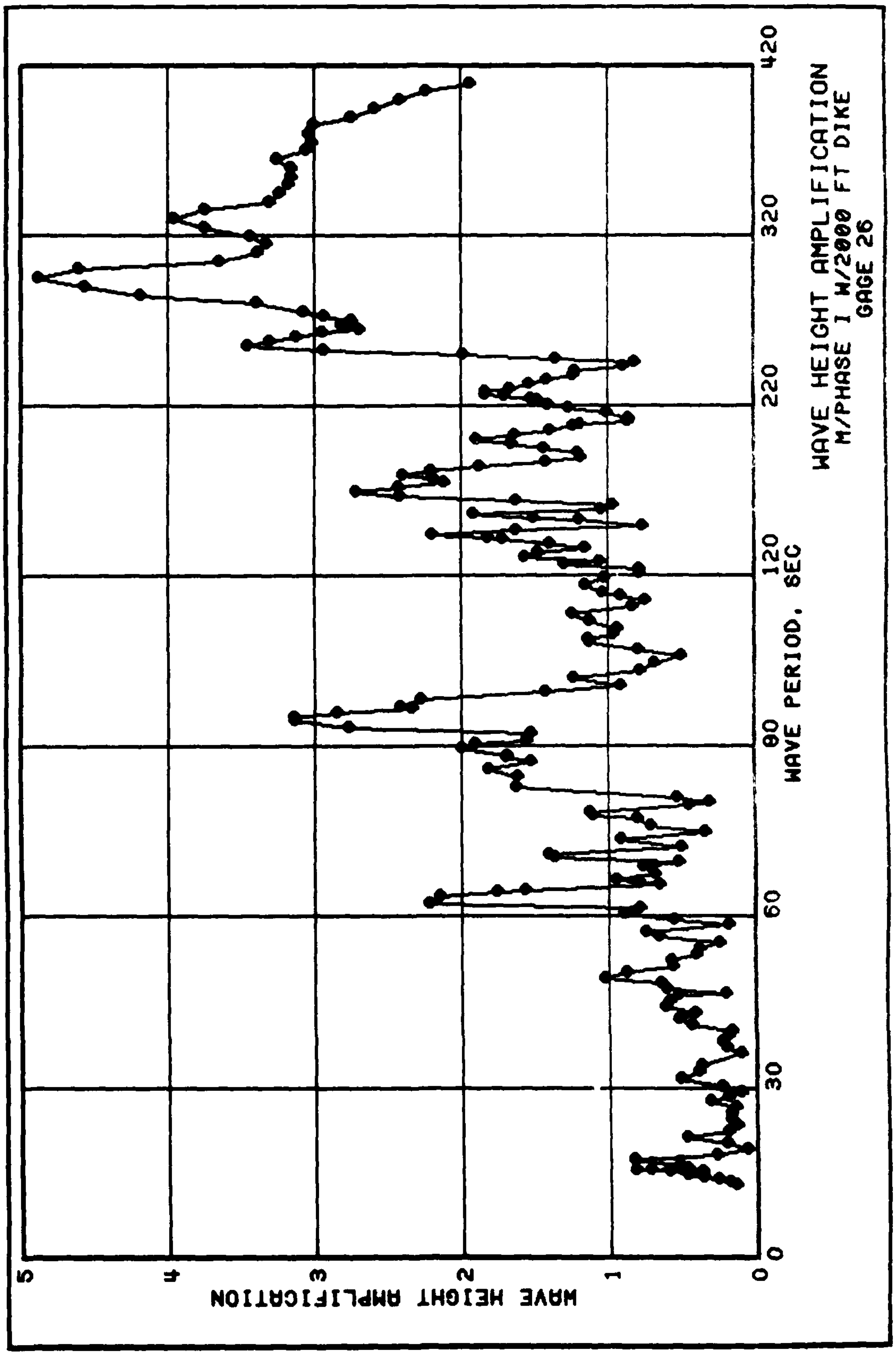
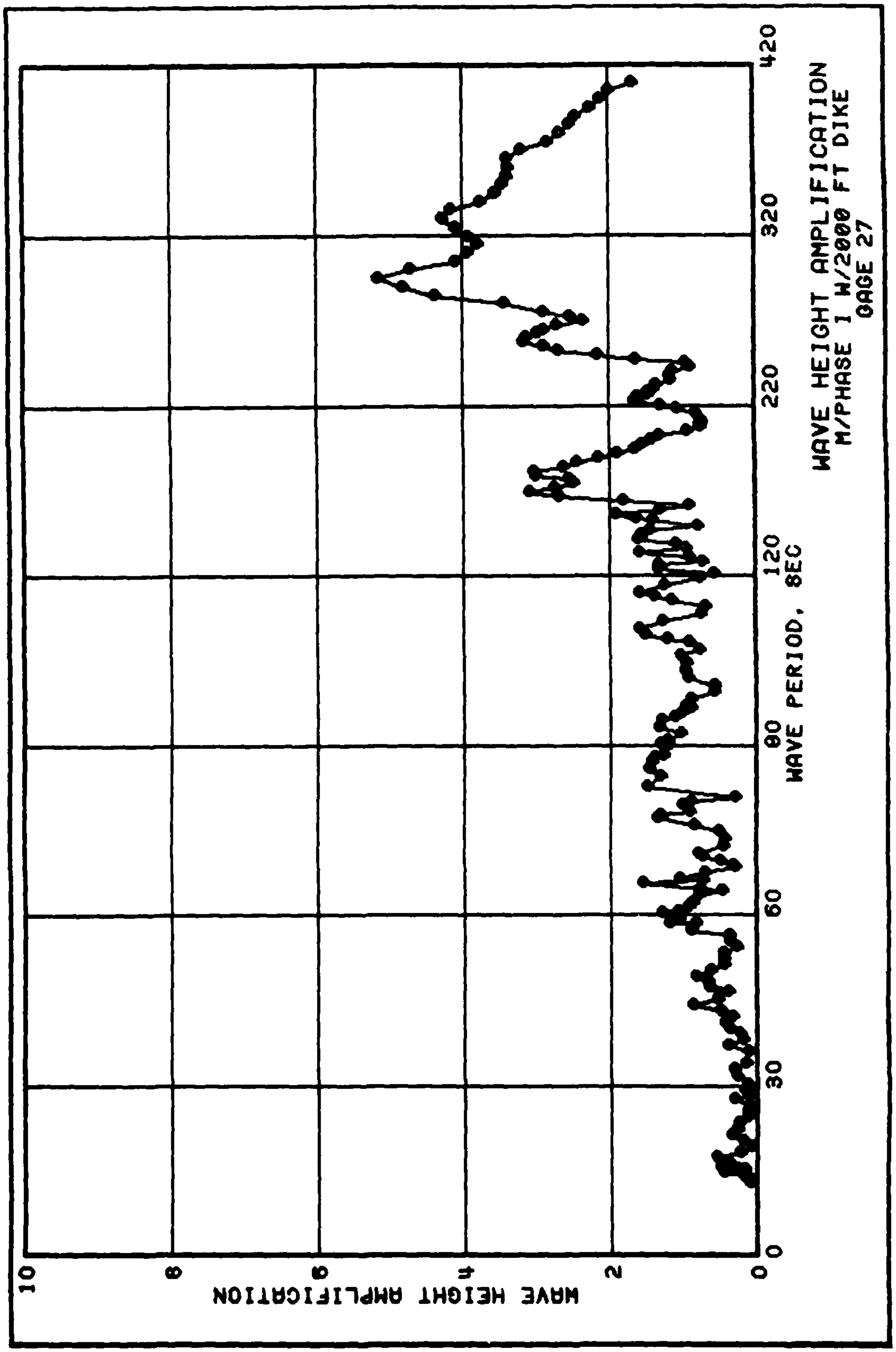

WAVE HEIGHT AMPLIFICATION
M/PHASE I W/2000 FT DIKE
GAGE 26
WAVE PERIOD, SEC
WAVE HEIGHT AMPLIFICATION
0
30
60
90
120
220
320
420
0
1
2
3
4
5

PLATE 58


WAVE HEIGHT AMPLIFICATION
M/PHASE 1 W/2000 FT DIKE
GAGE 27
WAVE PERIOD, SEC
WAVE HEIGHT AMPLIFICATION
0
2
4
6
8
10
0
30
60
90
120
220
320
420

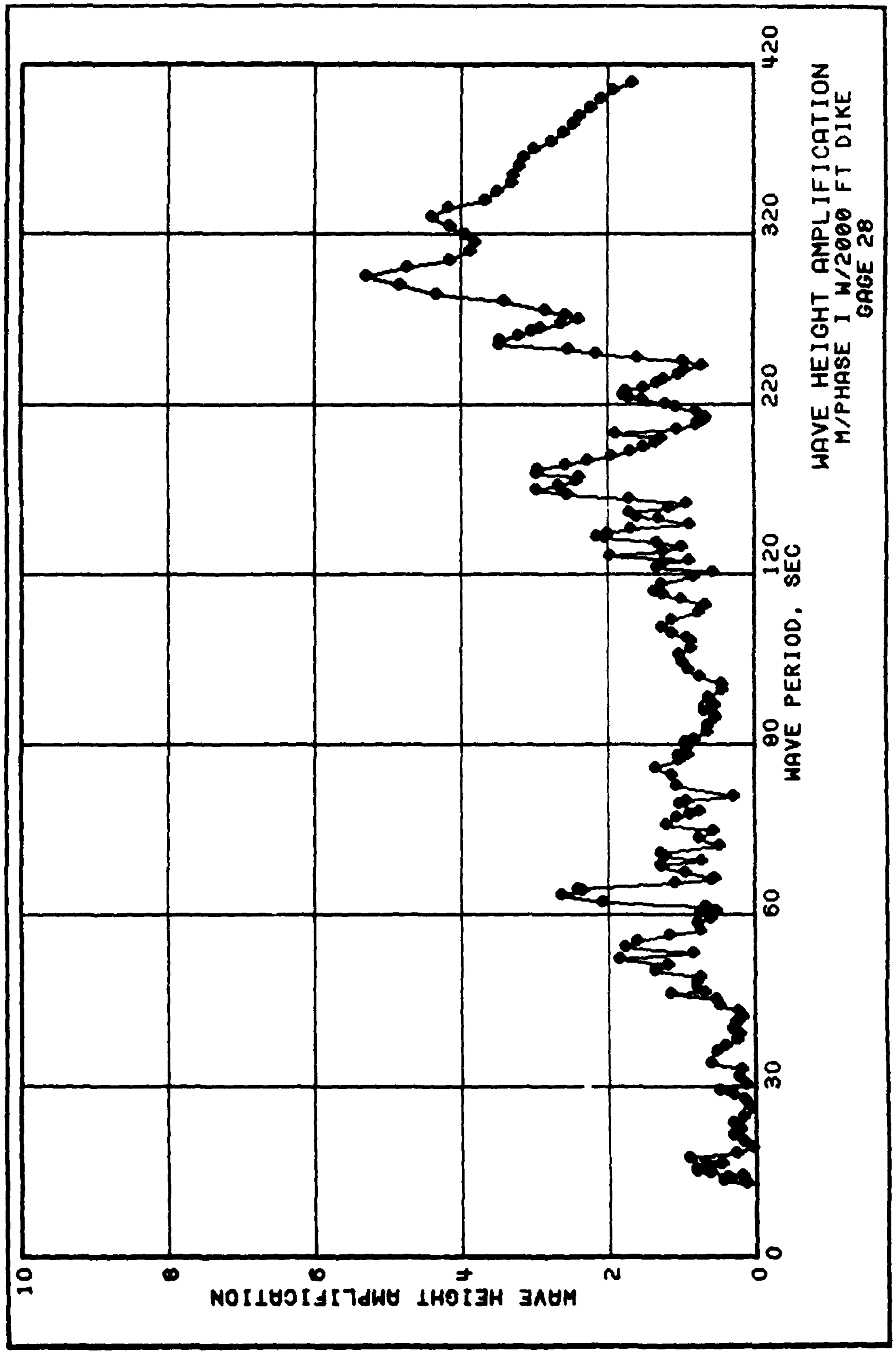
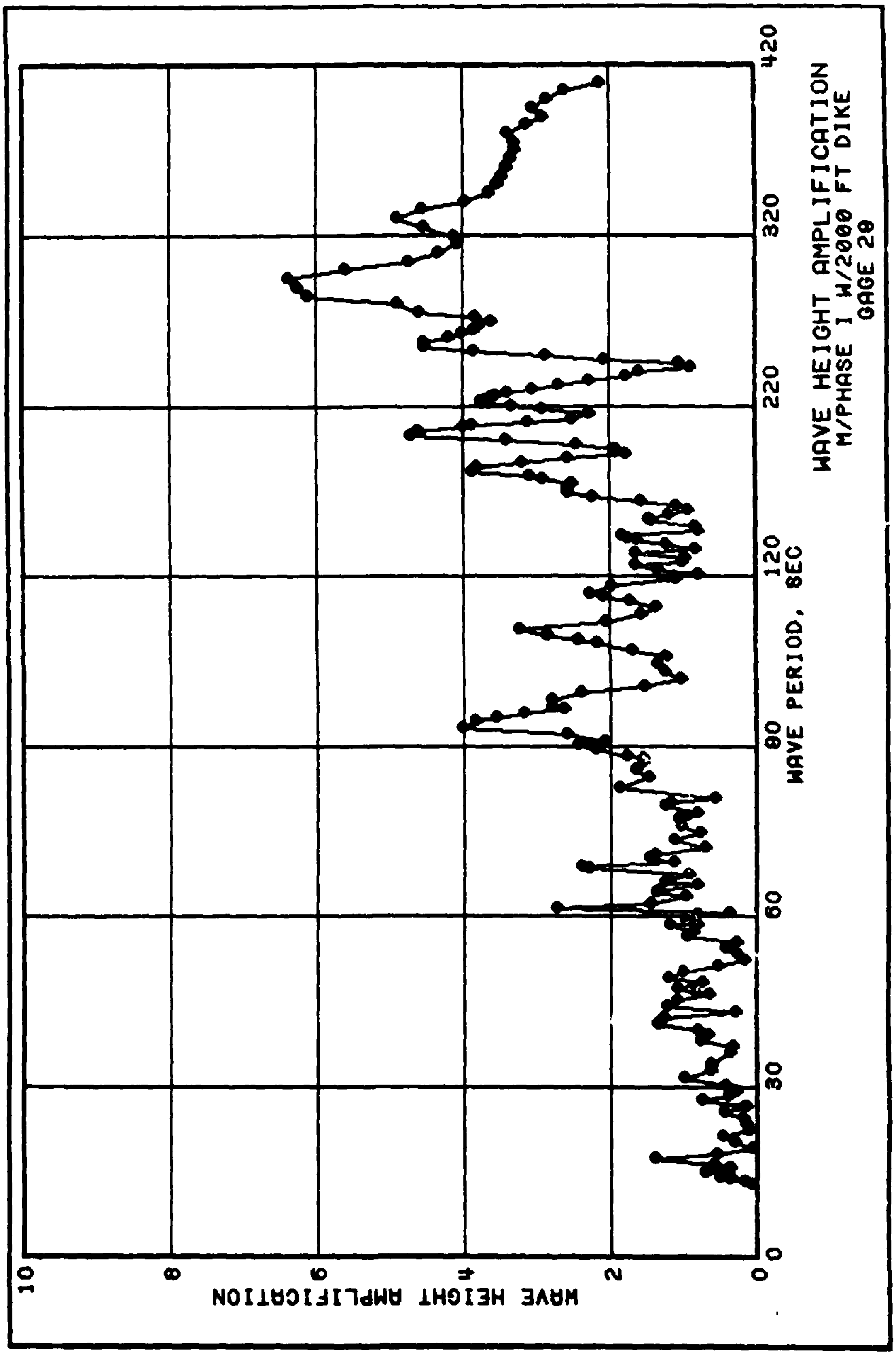

WAVE HEIGHT AMPLIFICATION
M/PHASE I W/2000 FT DIKE
GAGE 28
WAVE PERIOD, SEC
WAVE HEIGHT AMPLIFICATION
0
30
60
90
120
220
320
420
0
2
4
6
8
10

PLATE 60


WAVE HEIGHT AMPLIFICATION
M/PHASE 1 W/2000 FT DIKE
GAGE 20
WAVE PERIOD, SEC
0
30
60
90
120
220
320
420
WAVE HEIGHT AMPLIFICATION
0
2
4
6
8
10

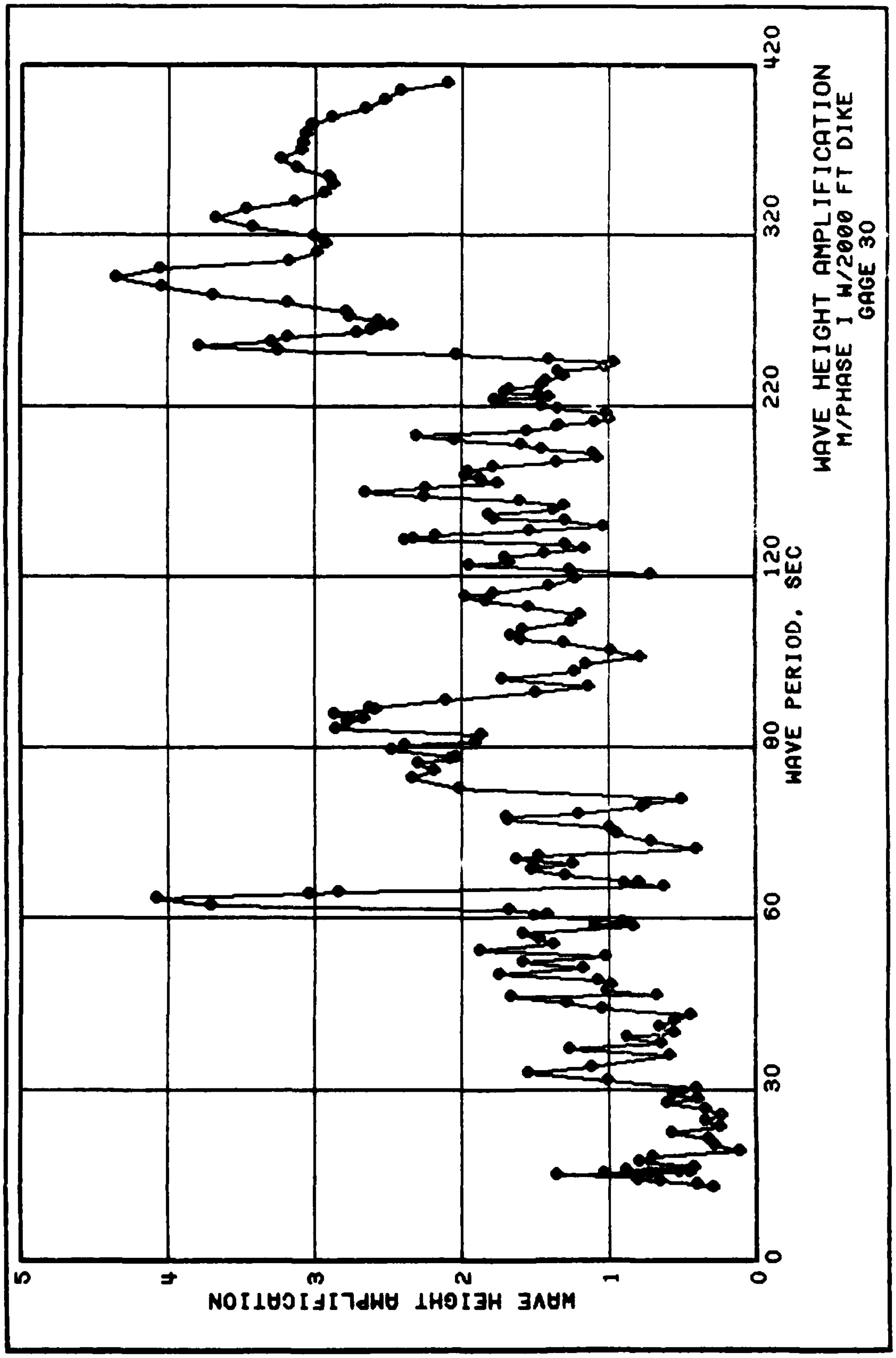

WAVE HEIGHT AMPLIFICATION
M/PHASE 1 W/2000 FT DIKE
GAGE 30
WAVE PERIOD, SEC
WAVE HEIGHT AMPLIFICATION
0
30
60
90
120
220
320
420
0
1
2
3
4
5

PLATE 62

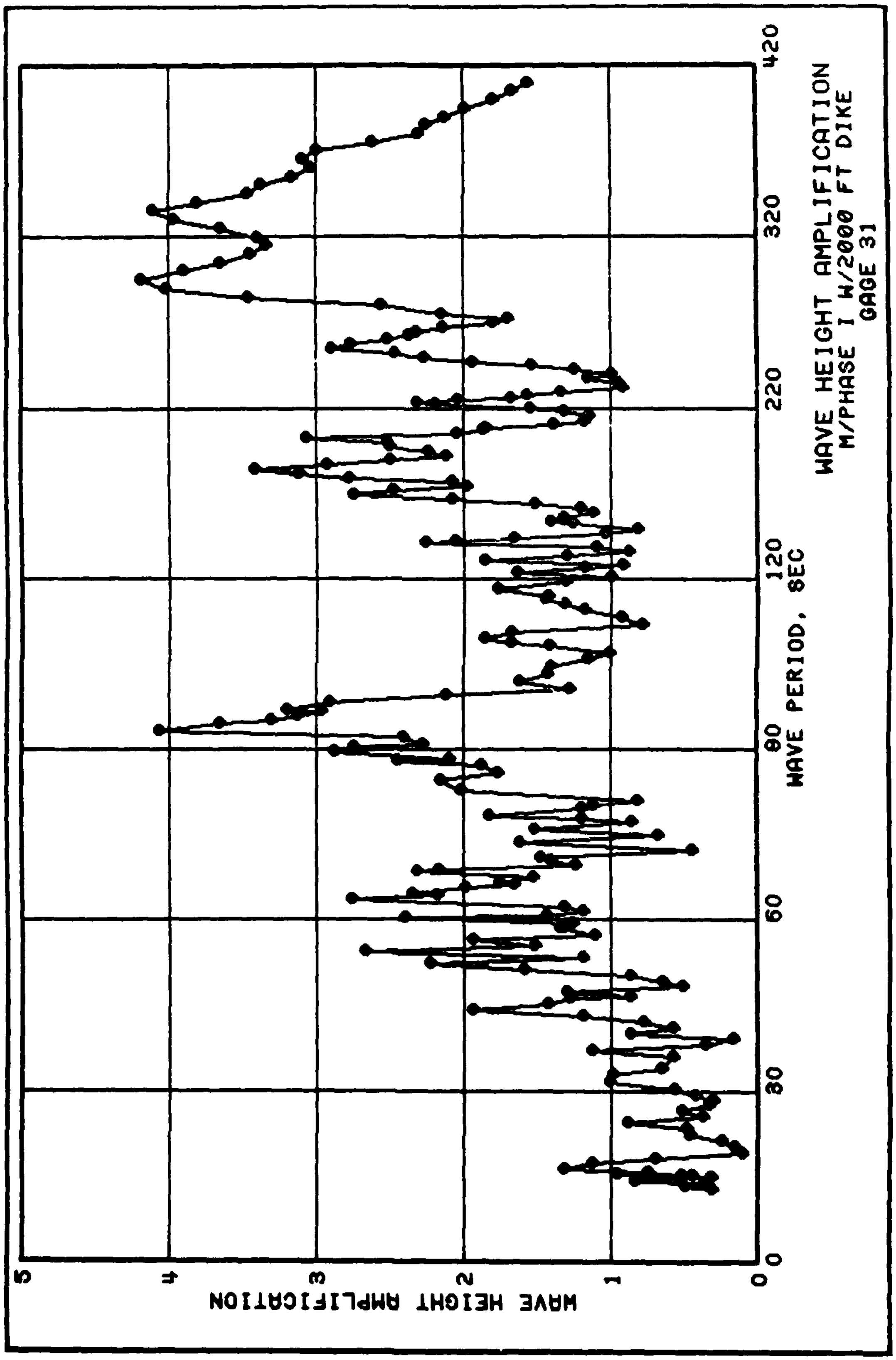

WAVE HEIGHT AMPLIFICATION
M/PHASE I W/2000 FT DIKE
GAGE 31
WAVE PERIOD, SEC
WAVE HEIGHT AMPLIFICATION
0
30
60
90
120
220
320
420
0
1
2
3
4
5

PLATE 63

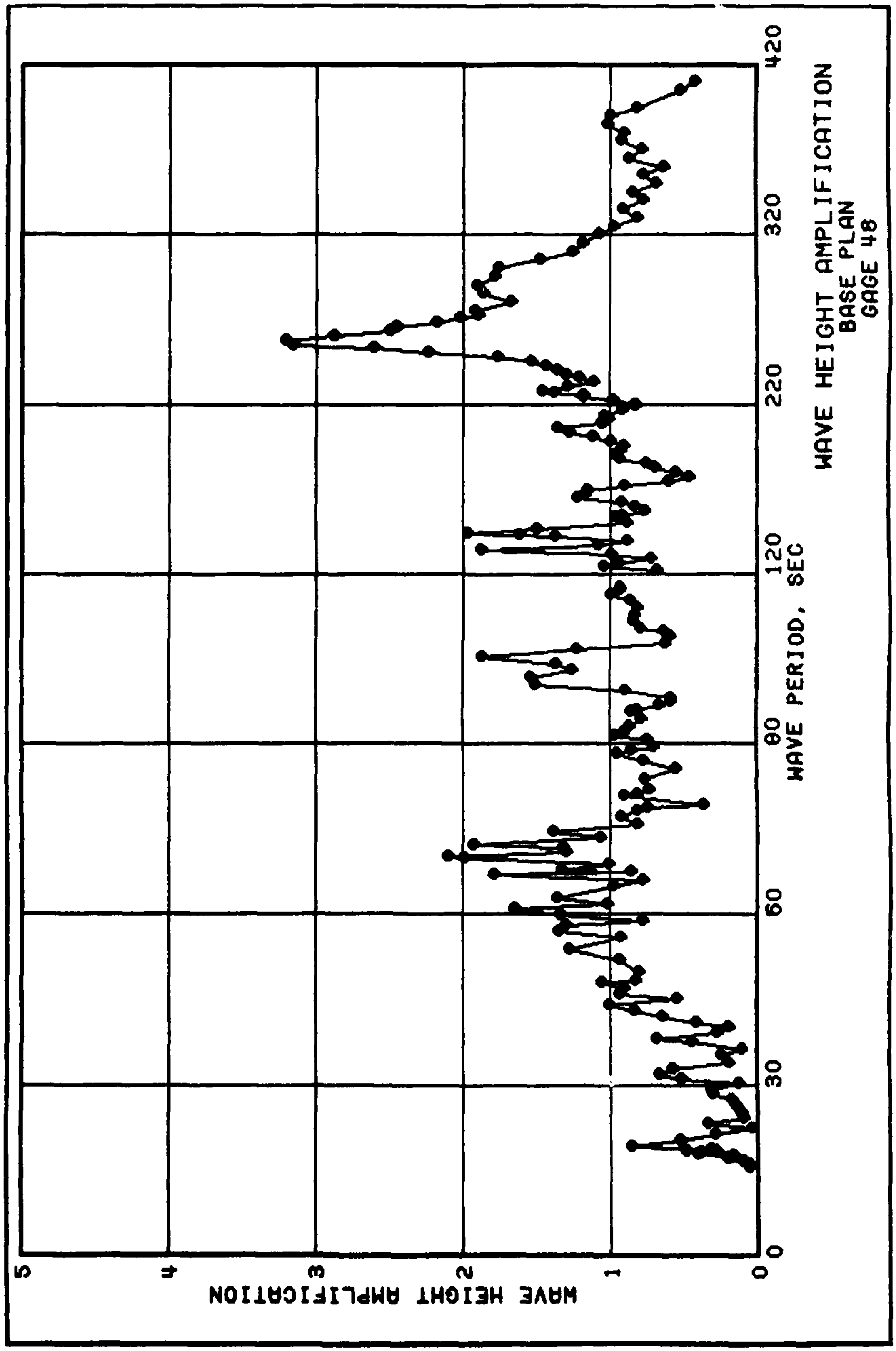
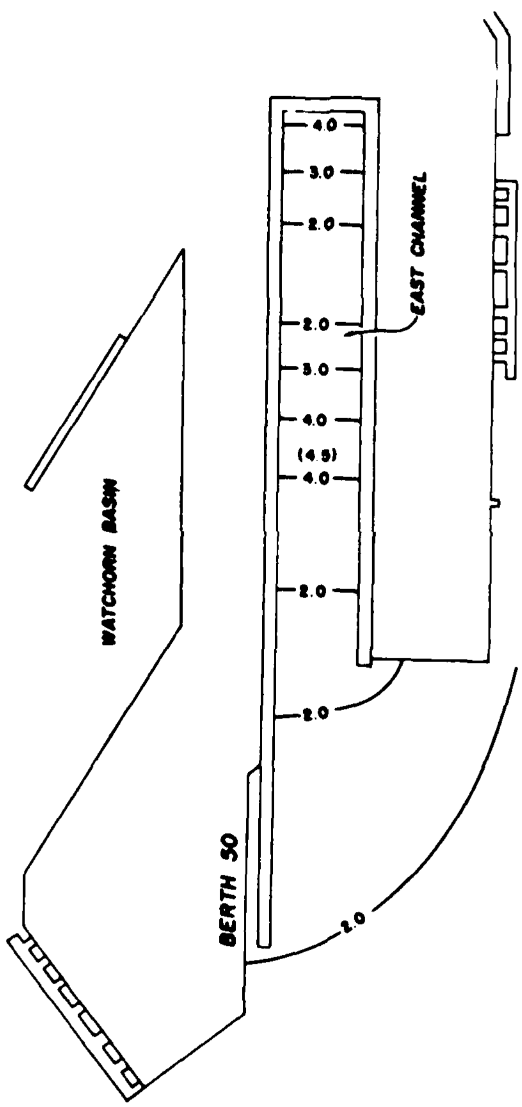

WAVE HEIGHT AMPLIFICATION
BASE PLAN
GAGE 48
WAVE PERIOD, SEC
WAVE HEIGHT AMPLIFICATION
0
30
60
90
120
220
320
420
0
1
2
3
4
5

PLATE 64



BASE PLAN
CONTOURS OF
WAVE HEIGHT AMPLIFICATION
EAST CHANNEL
96 SEC

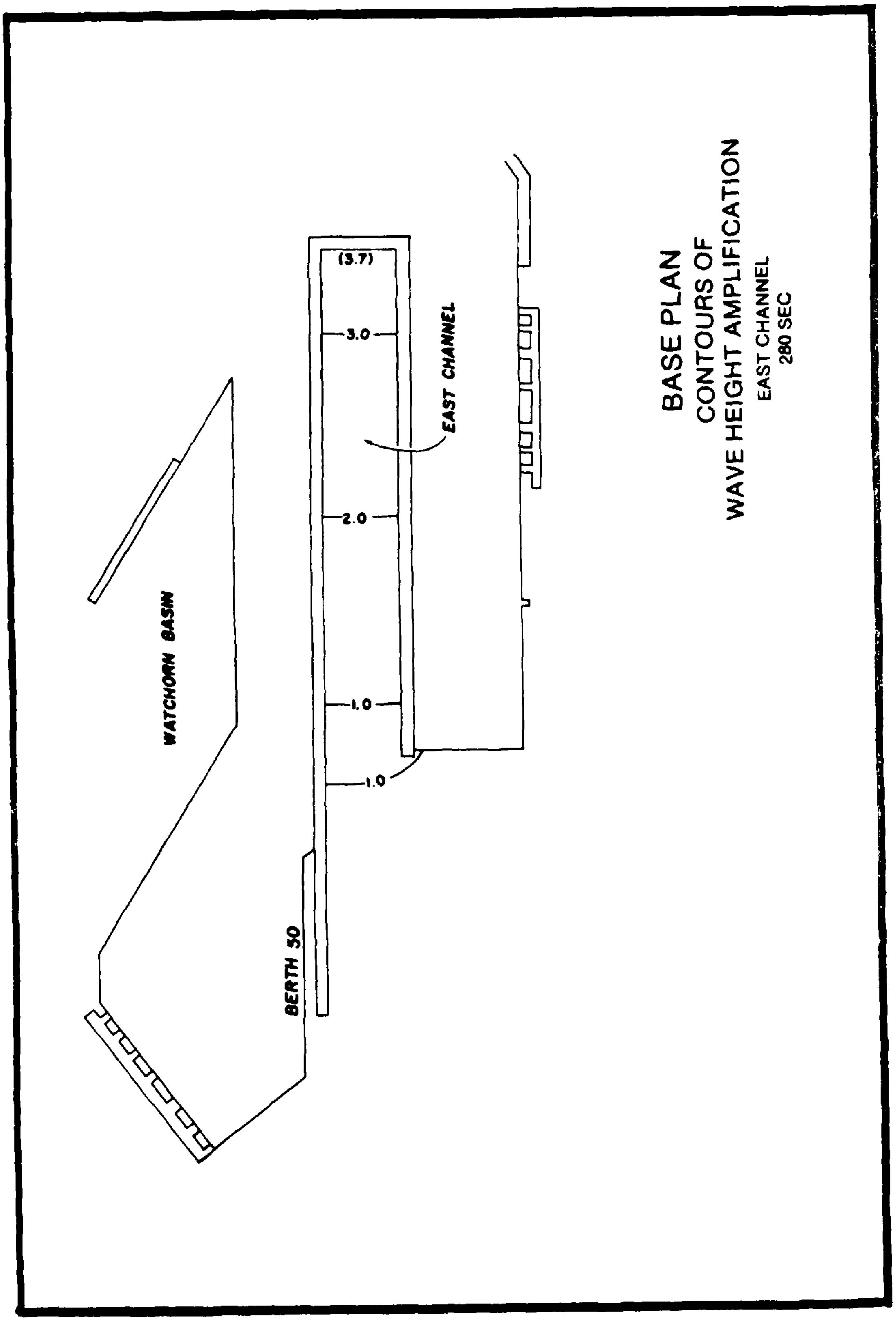
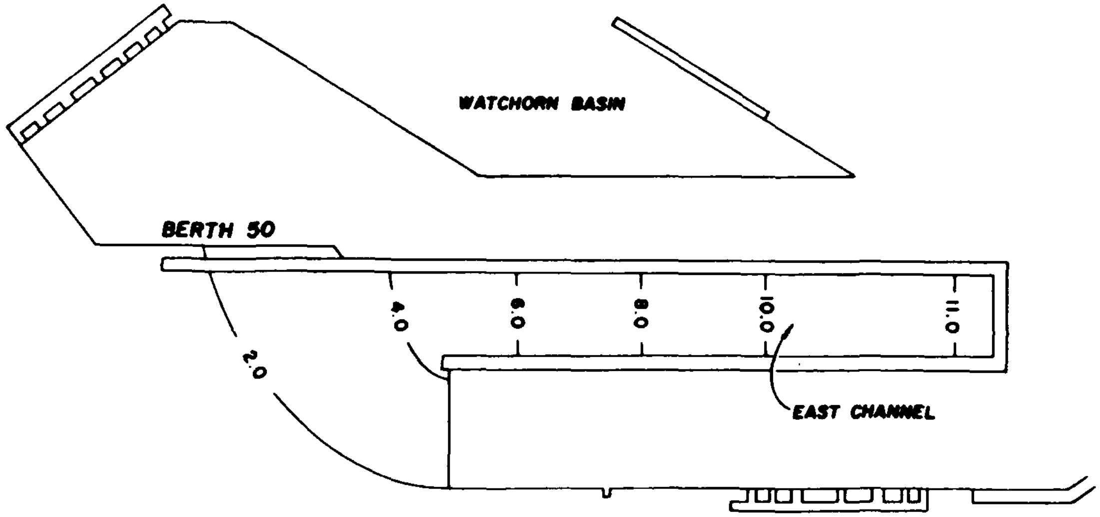

BASE PLAN
CONTOURS OF
WAVE HEIGHT AMPLIFICATION
EAST CHANNEL
280 SEC
WATCHORN BASIN
EAST CHANNEL
BERTH 50
(3.7)
3.0
2.0
1.0
1.0

PLATE 66



BASE PLAN
CONTOURS OF
WAVE HEIGHT AMPLIFICATION
EAST CHANNEL
385 SEC

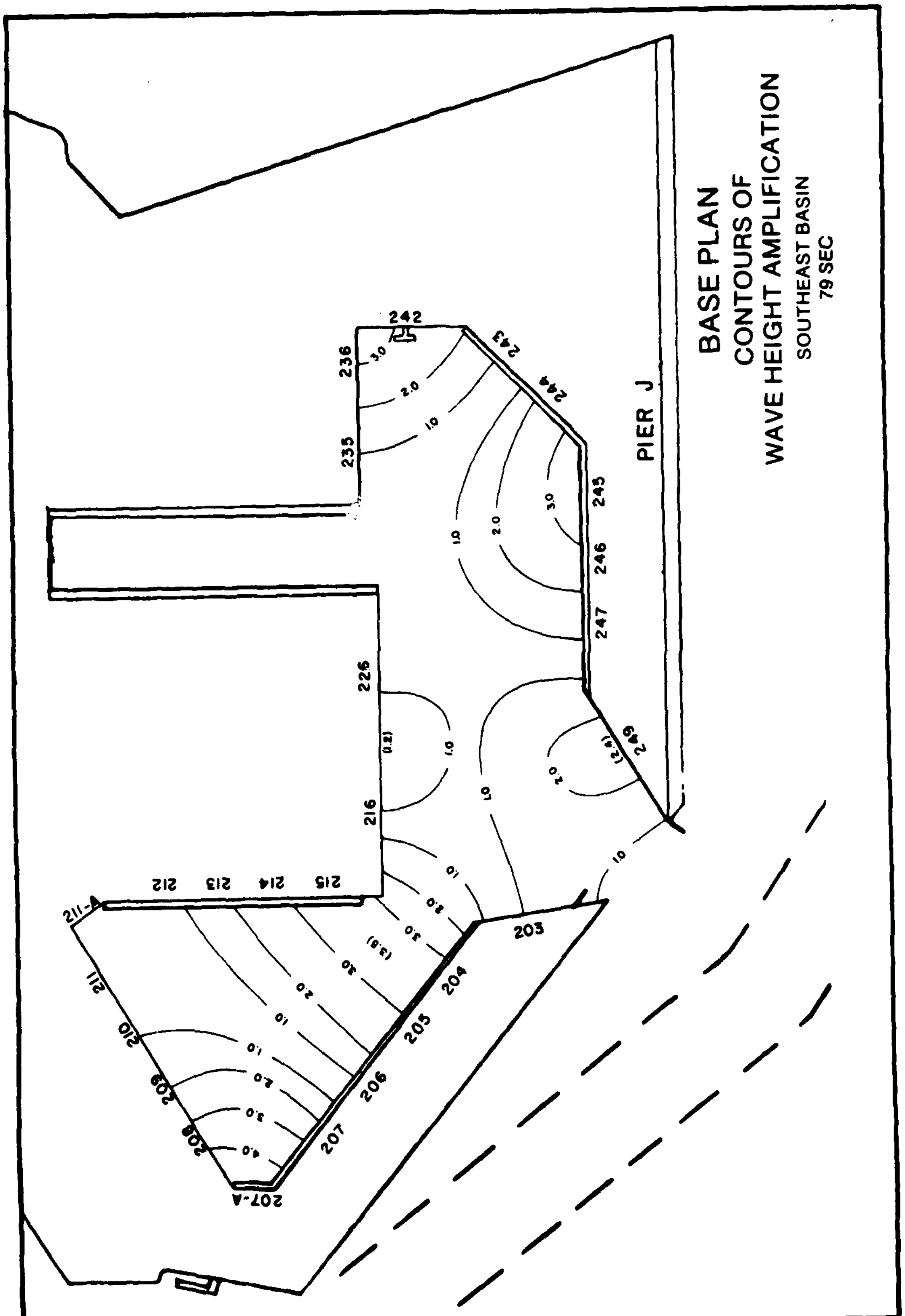
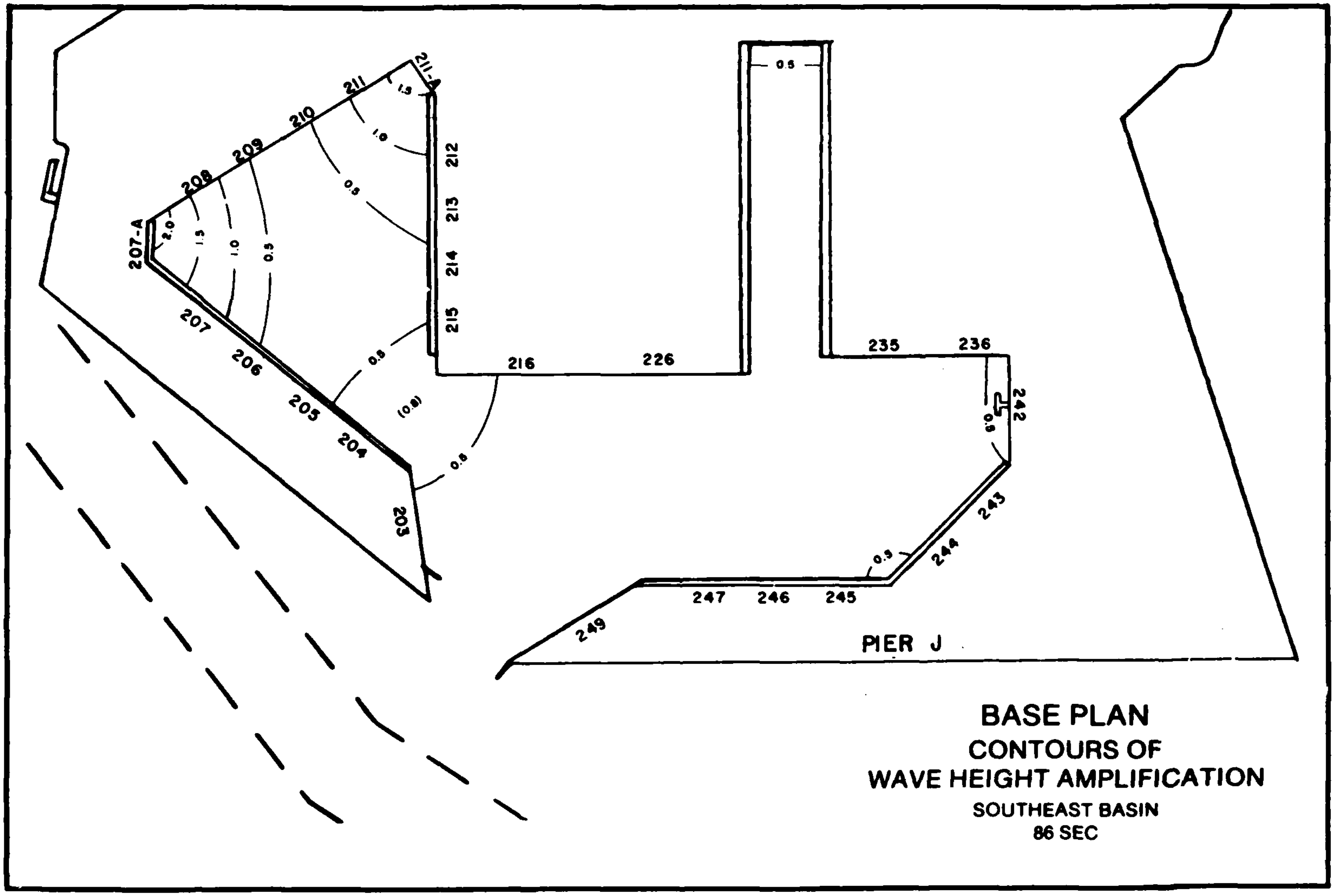

BASE PLAN
CONTOURS OF
WAVE HEIGHT AMPLIFICATION
SOUTHEAST BASIN
79 SEC
PIER J

PLATE 68



BASE PLAN
CONTOURS OF
WAVE HEIGHT AMPLIFICATION
SOUTHEAST BASIN
86 SEC

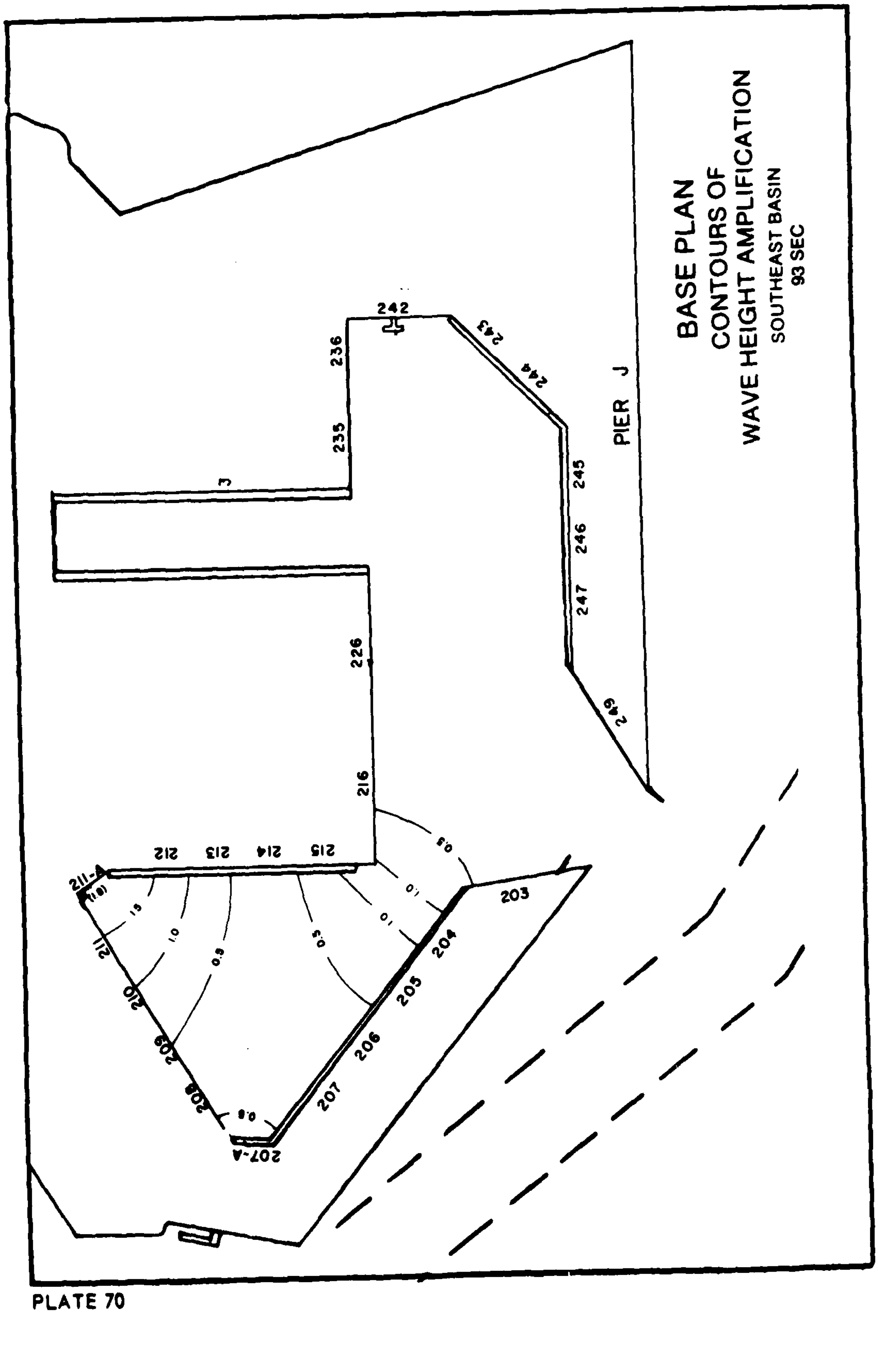
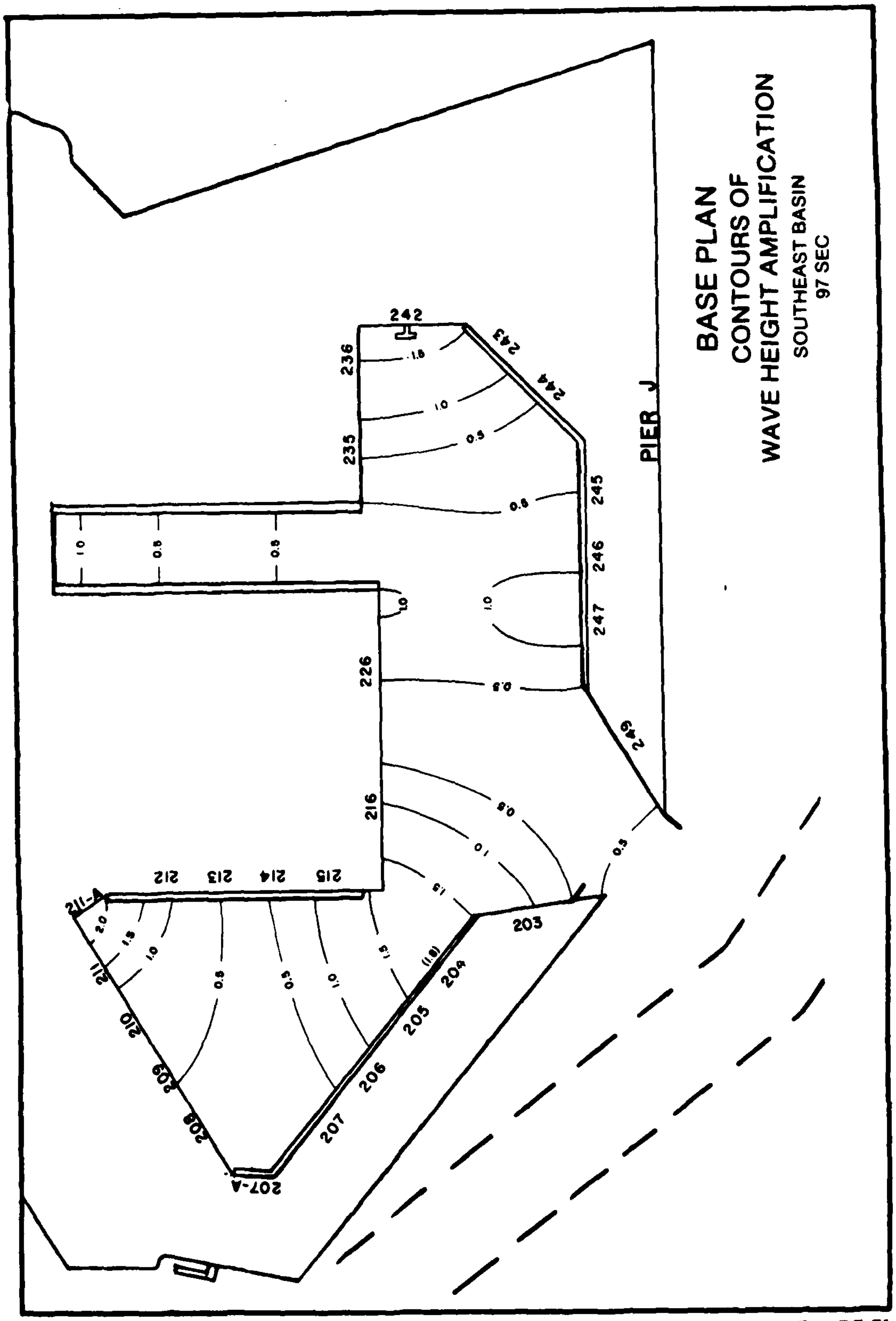

BASE PLAN
CONTOURS OF
WAVE HEIGHT AMPLIFICATION
SOUTHEAST BASIN
93 SEC
PIER J
242
243
244
245
246
247
249
236
235
226
216
215
214
213
212
211-A
211
210
209
208
207-A
207
206
205
204
203

PLATE 70


BASE PLAN
CONTOURS OF
WAVE HEIGHT AMPLIFICATION
SOUTHEAST BASIN
97 SEC
PIER J
242
243
244
245
246
247
249
236
235
226
216
215
214
213
212
211-A
211
210
209
208
207-A
207
206
205
204
203
(1.8)
2.0
1.5
1.0
0.5

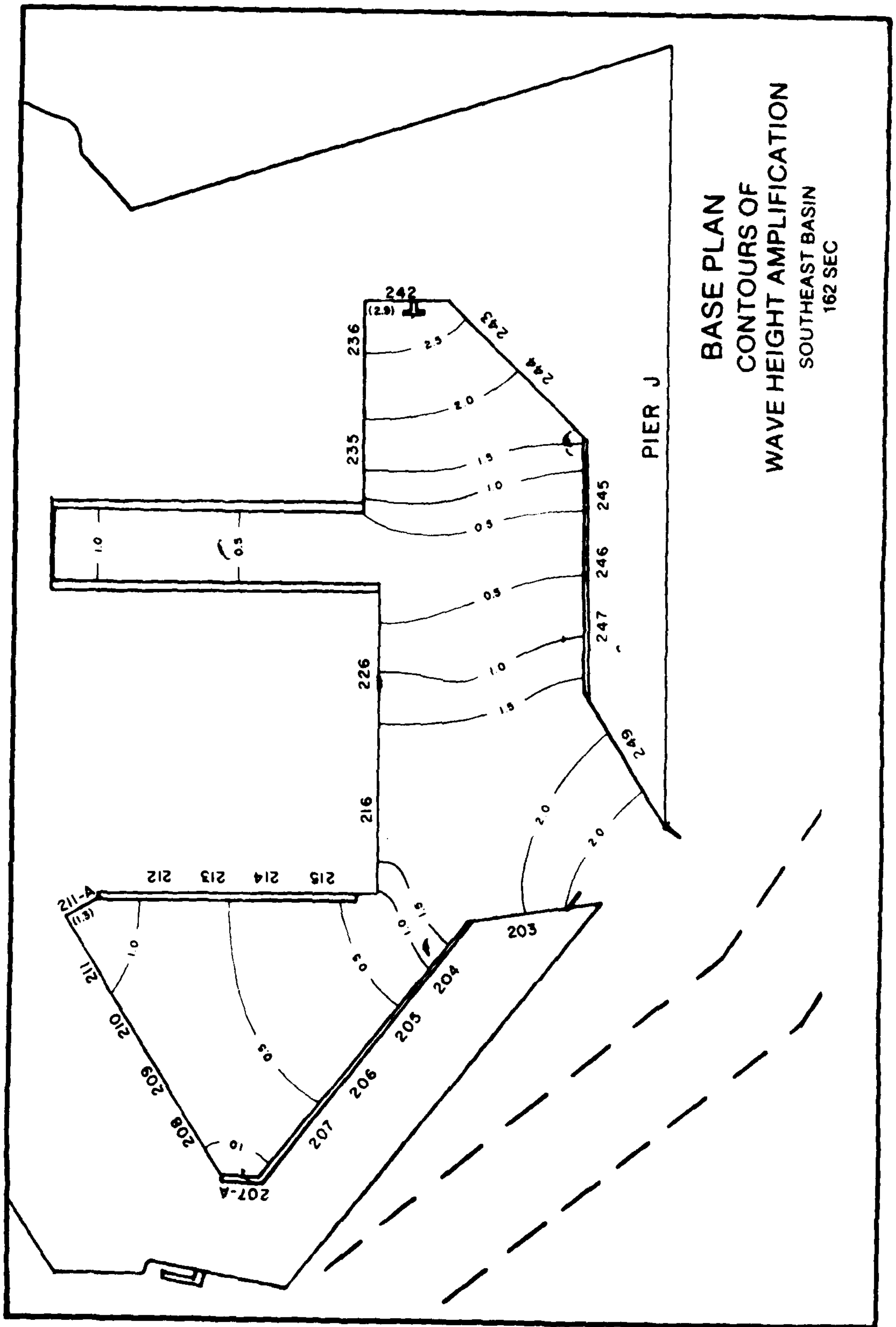
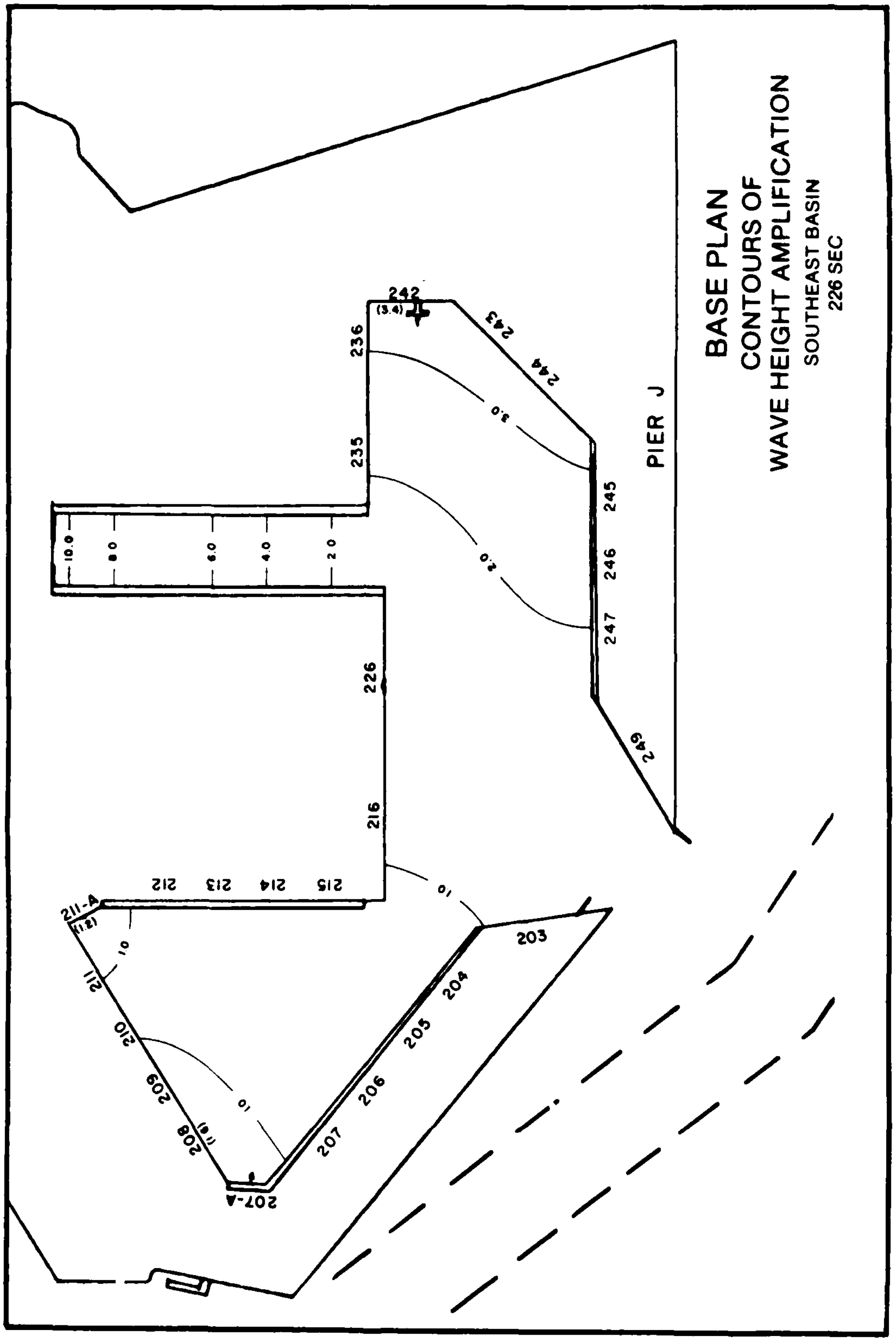
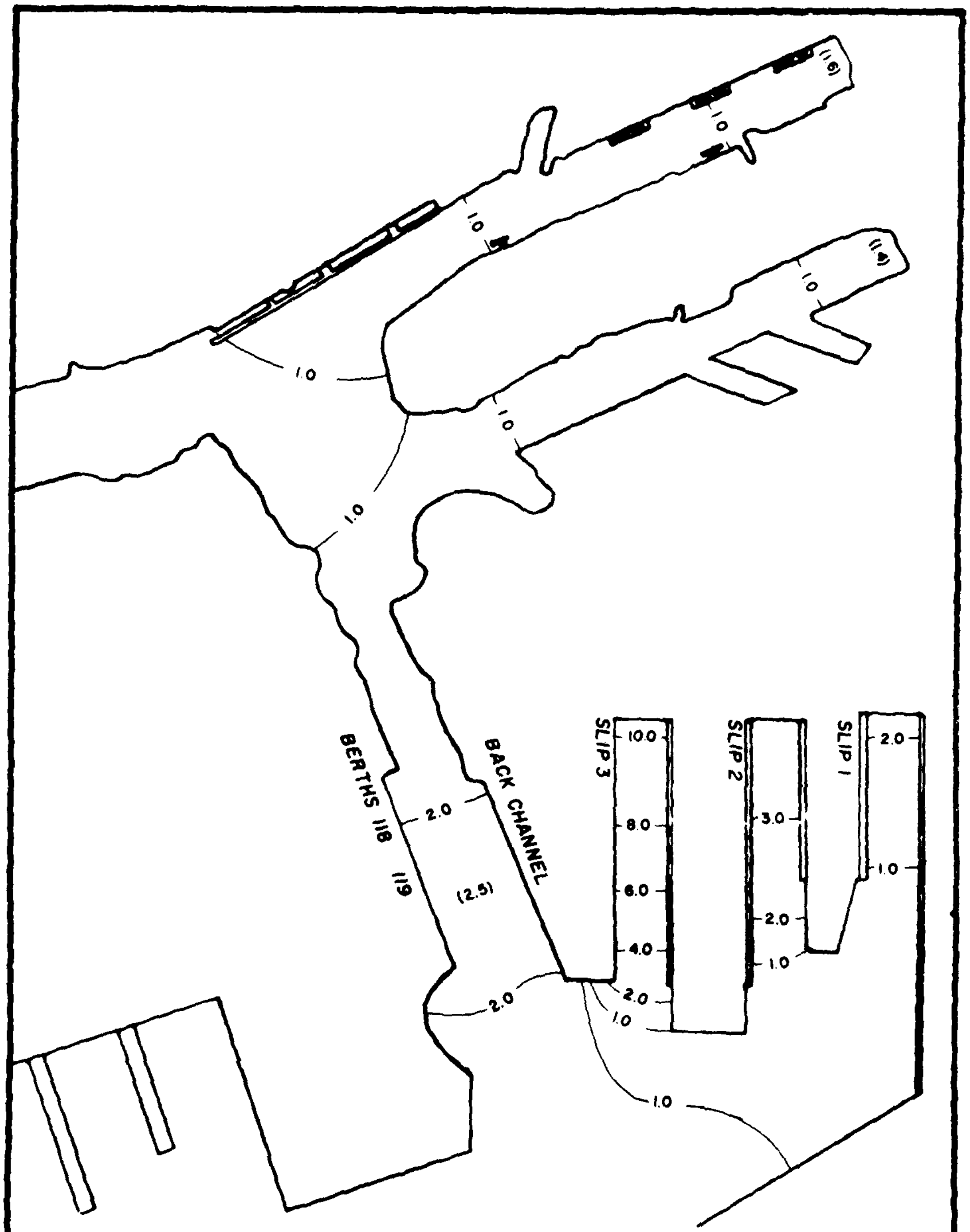

BASE PLAN
CONTOURS OF
WAVE HEIGHT AMPLIFICATION
SOUTHEAST BASIN
162 SEC
PIER J
242
(2.9)
236
235
243
244
245
246
247
249
226
216
215
214
213
212
211-A
(1.3)
211
210
209
208
207-A
207
206
205
204
203
2.5
2.0
1.5
1.0
0.5

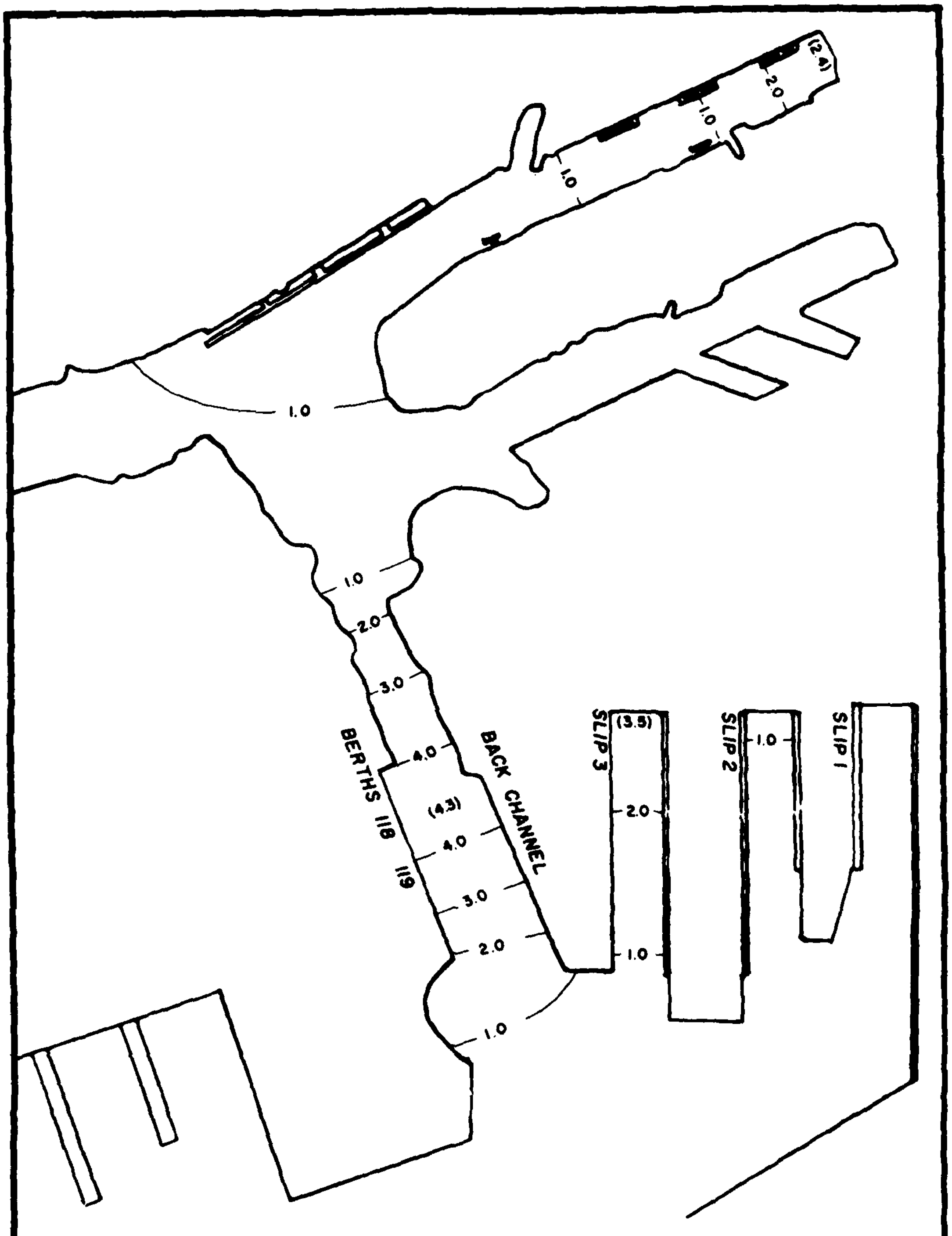
PLATE 72


BASE PLAN
CONTOURS OF
WAVE HEIGHT AMPLIFICATION
SOUTHEAST BASIN
226 SEC
PIER J
203
204
205
206
207
207-A
208
209
210
211
211-A
212
213
214
215
216
226
235
236
242
243
244
245
246
247
249
10.0
8.0
6.0
4.0
2.0
3.0
1.0



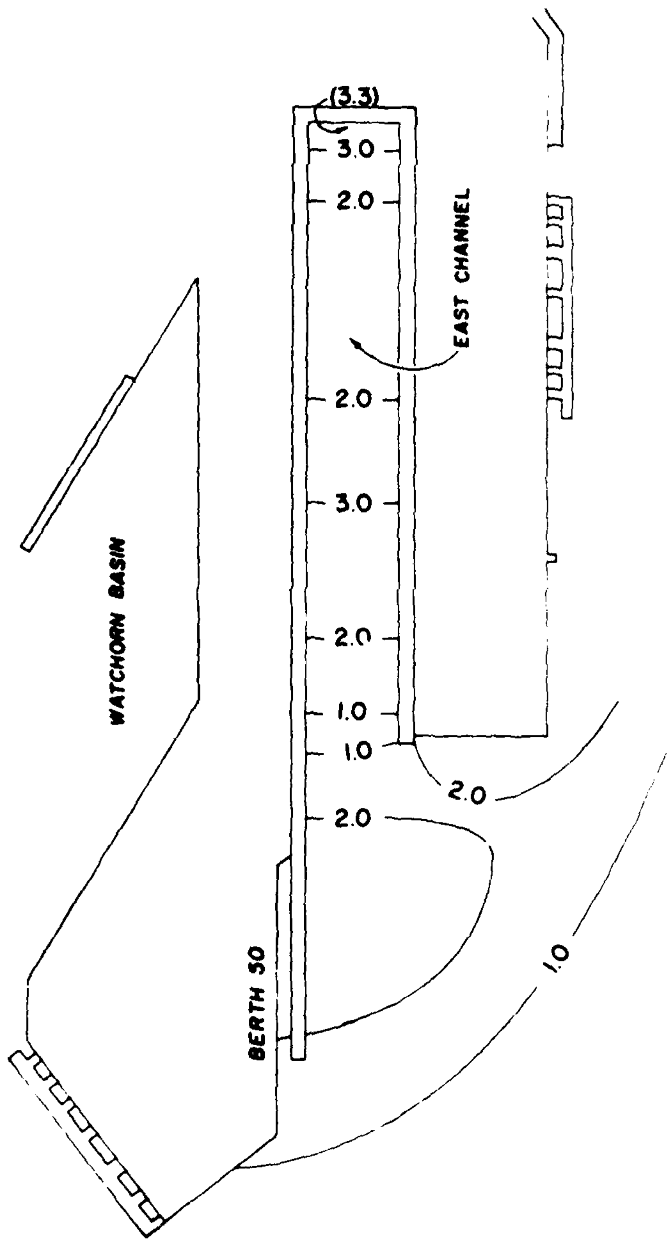
BASE PLAN
CONTOURS OF
WAVE HEIGHT AMPLIFICATION
EAST BASIN
224 SEC

PLATE 74



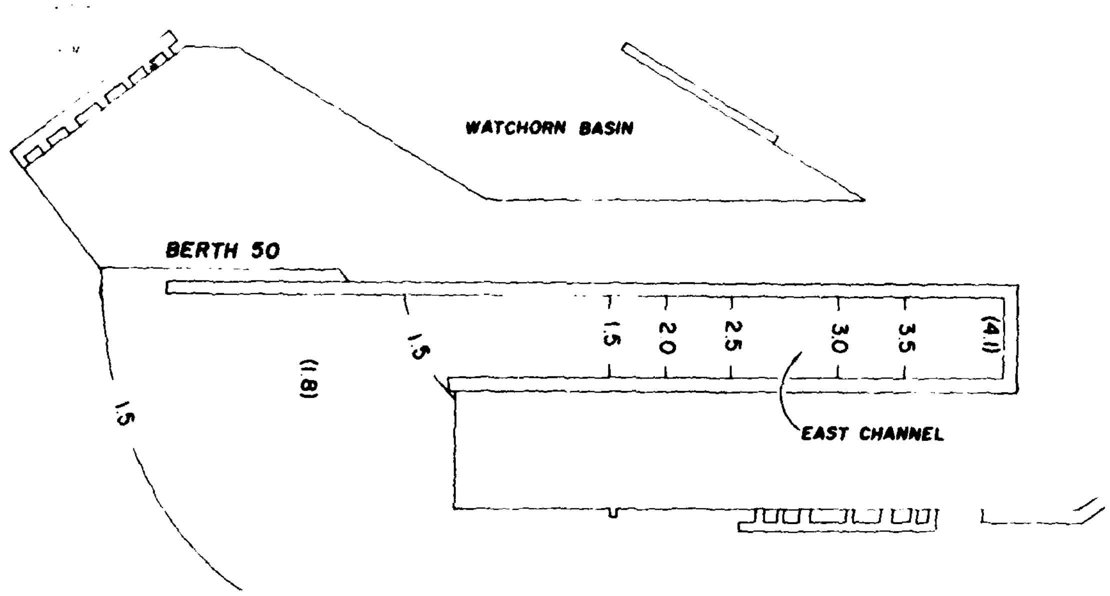
BASE PLAN
CONTOURS OF
WAVE HEIGHT AMPLIFICATION
BACK CHANNEL
204 SEC

PLATE 75

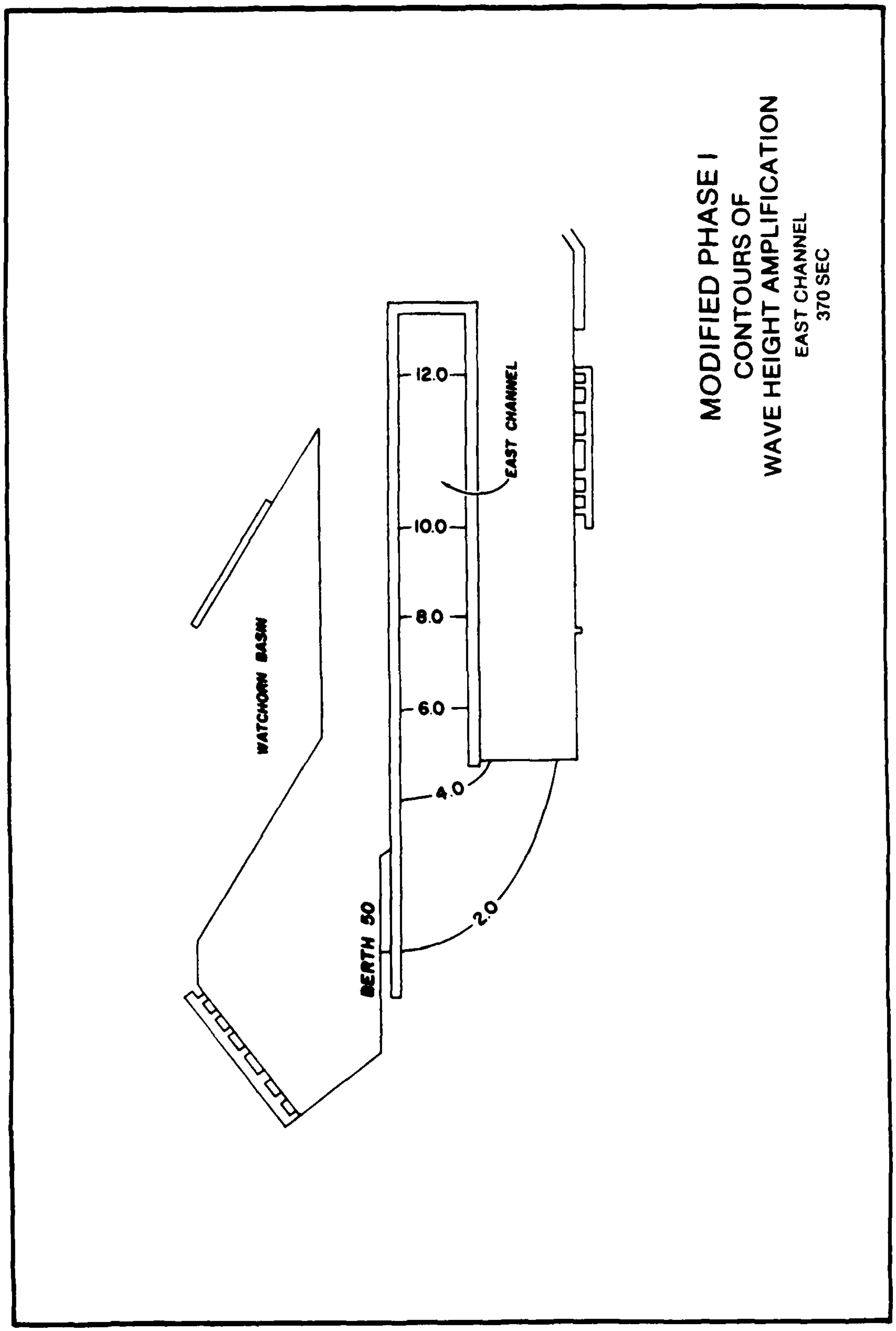


MODIFIED PHASE I
CONTOURS OF
WAVE HEIGHT AMPLIFICATION
EAST CHANNEL
95 SEC

PLATE 76

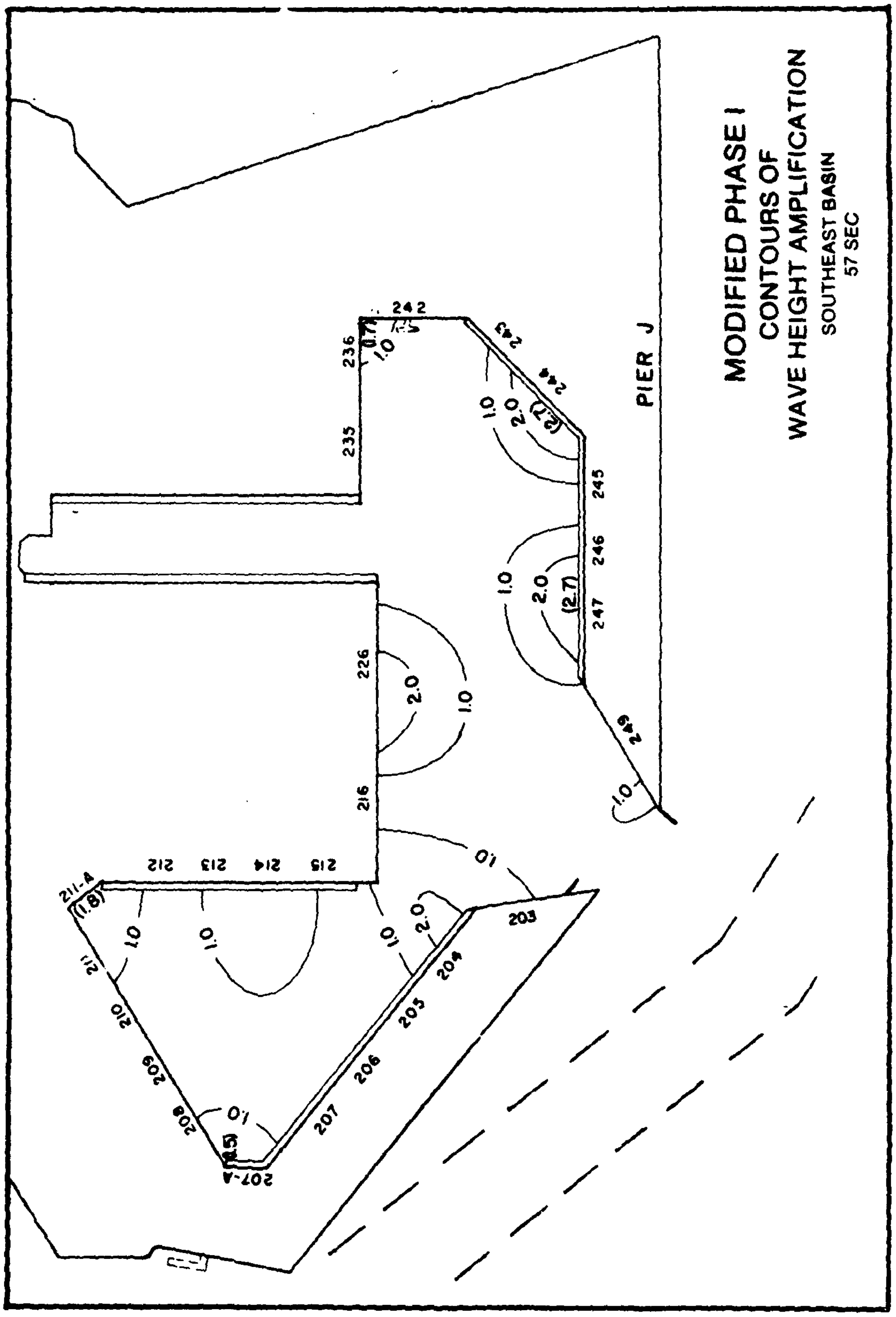


MODIFIED PHASE I
CONTOURS OF
WAVE HEIGHT AMPLIFICATION
EAST CHANNEL
265 SEC

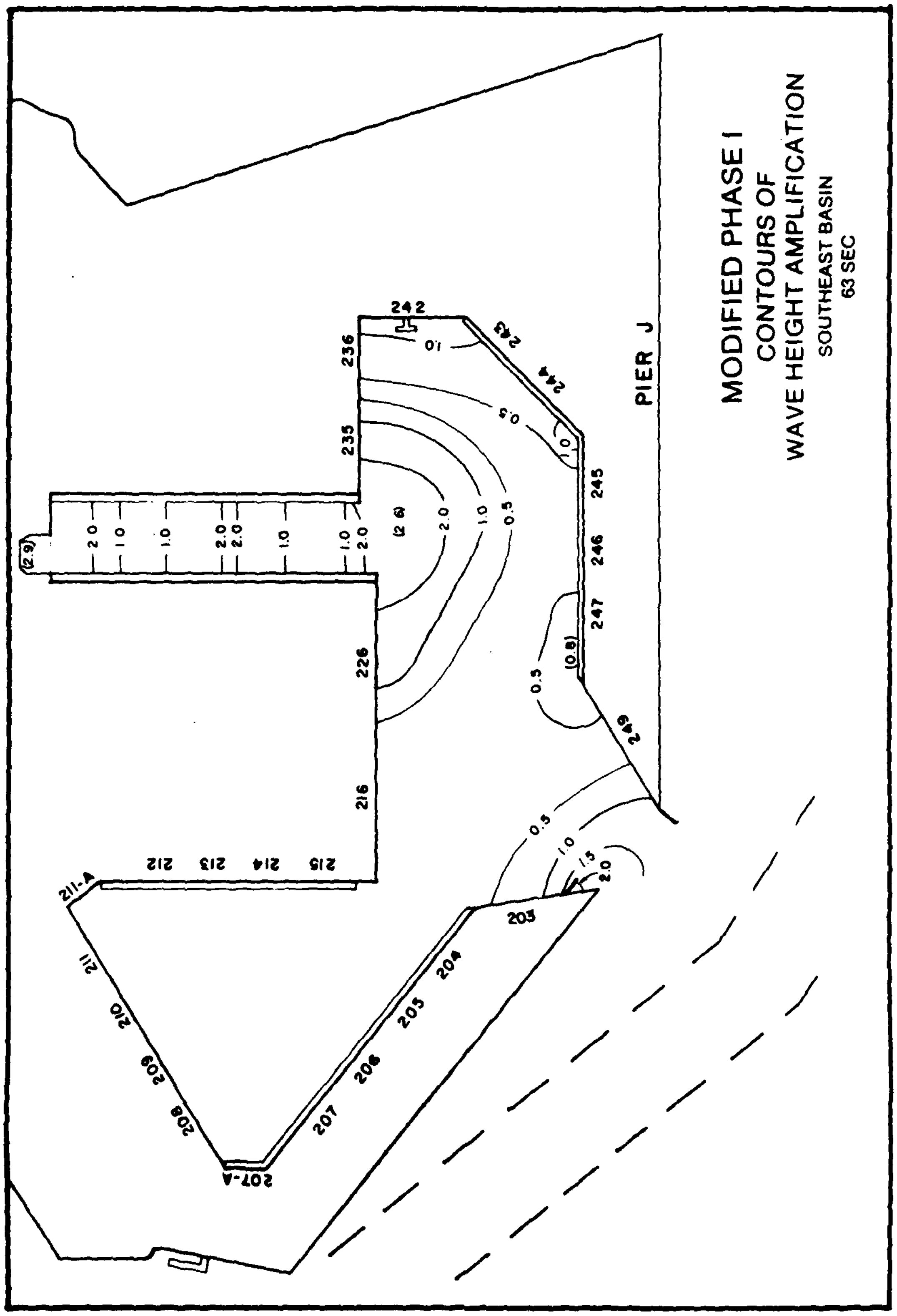


MODIFIED PHASE I
CONTOURS OF
WAVE HEIGHT AMPLIFICATION
EAST CHANNEL
370 SEC

PLATE 78



MODIFIED PHASE I
CONTOURS OF
WAVE HEIGHT AMPLIFICATION
SOUTHEAST BASIN
57 SEC



MODIFIED PHASE I
CONTOURS OF
WAVE HEIGHT AMPLIFICATION
SOUTHEAST BASIN
63 SEC
PIER J

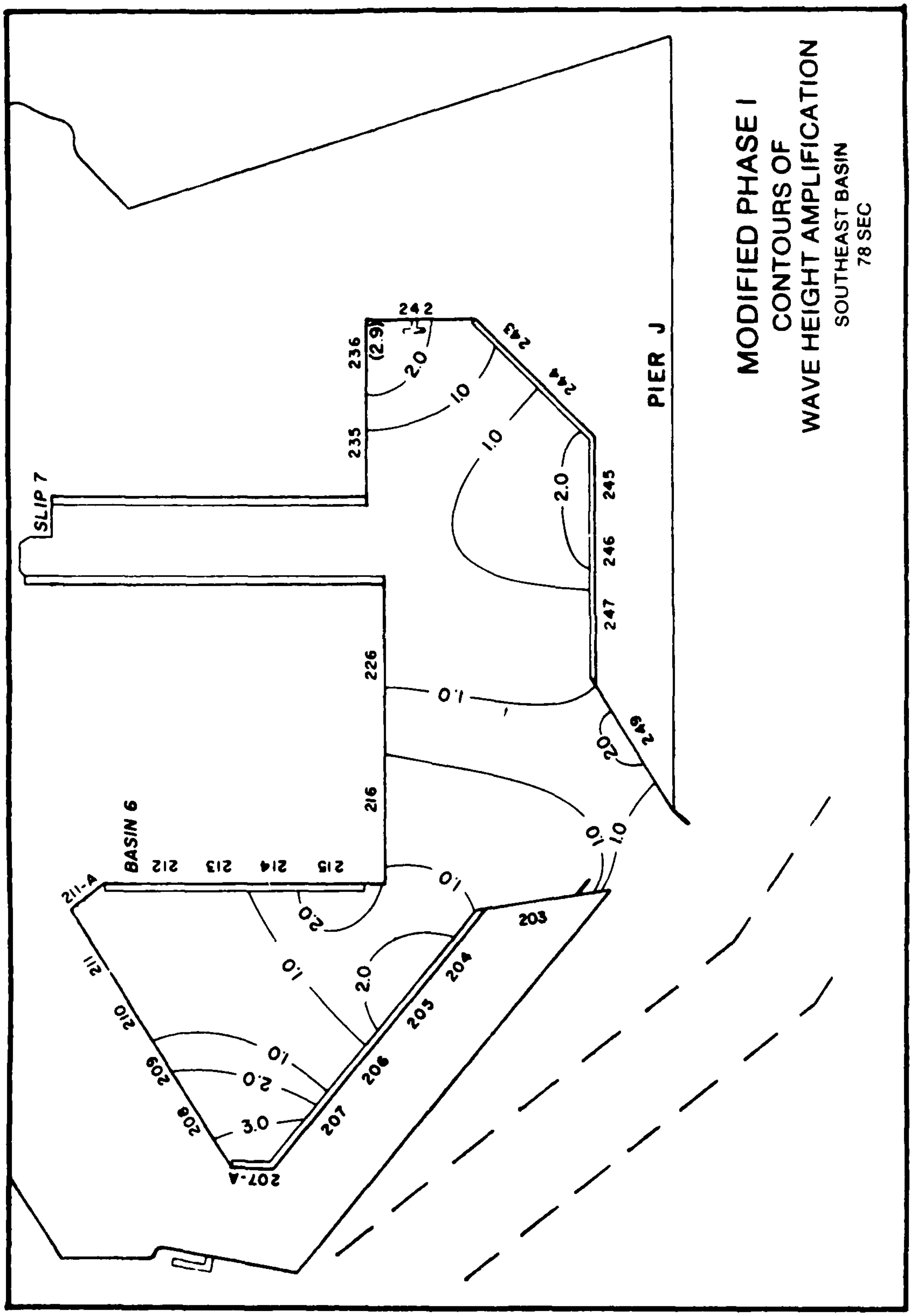
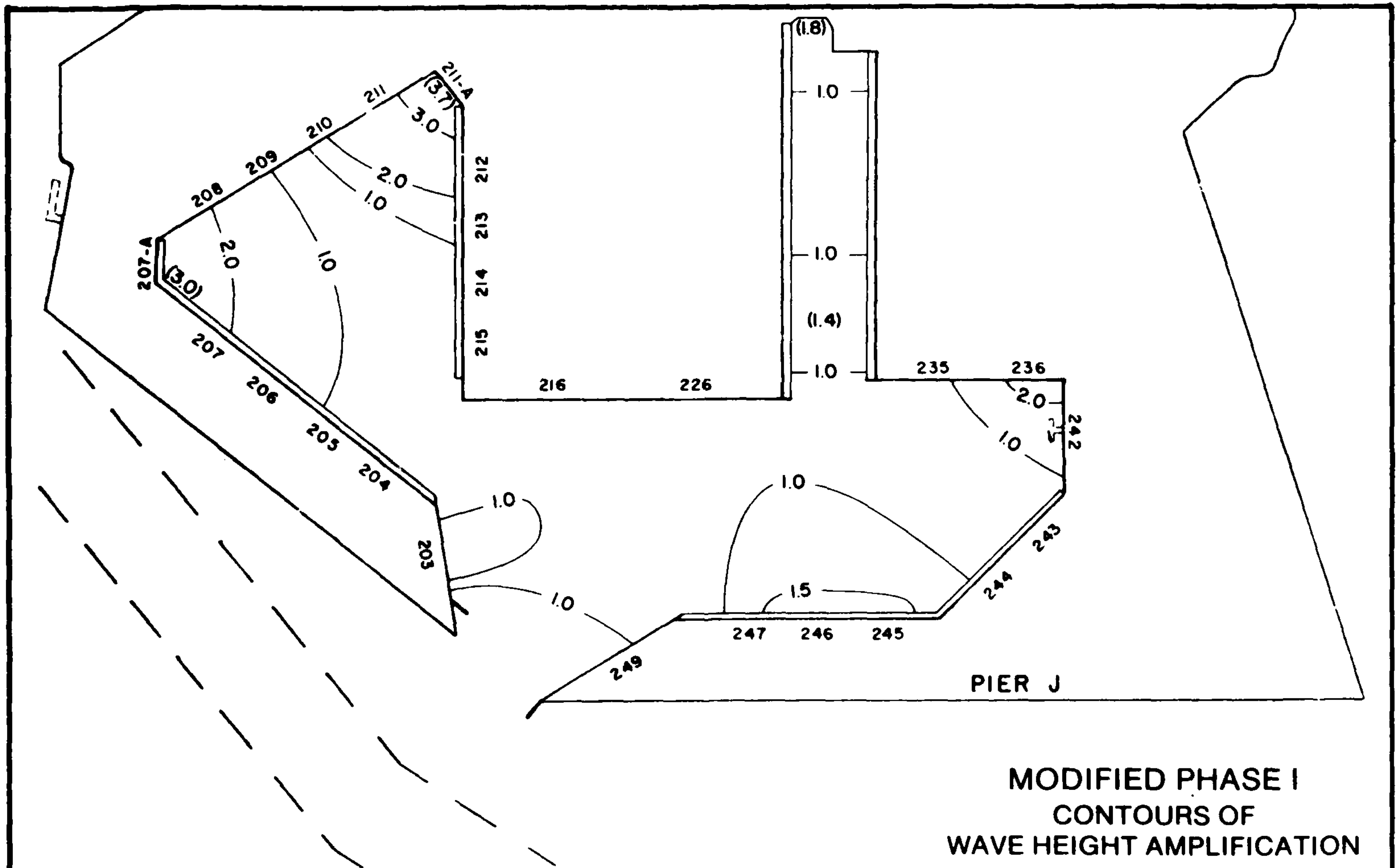
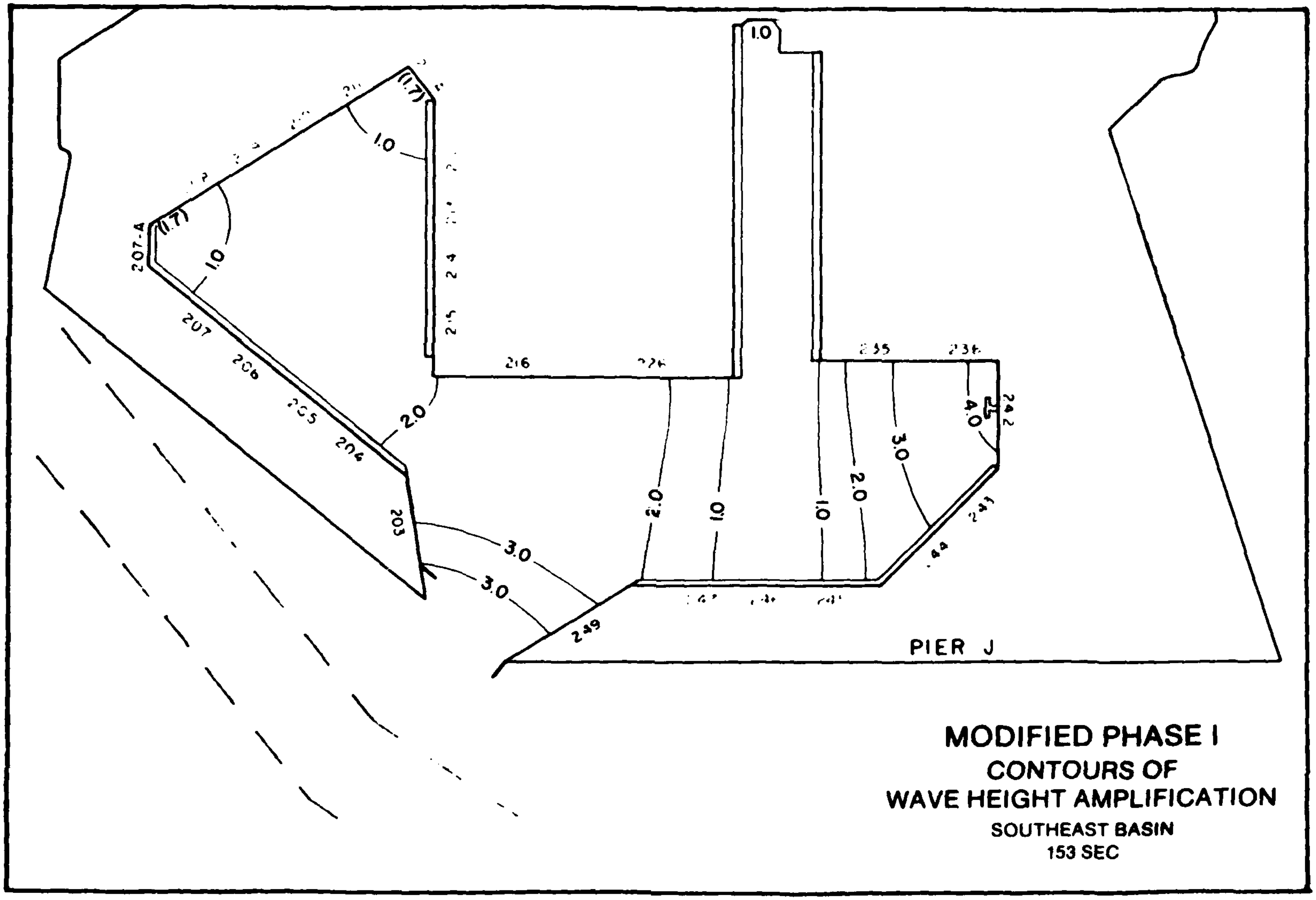
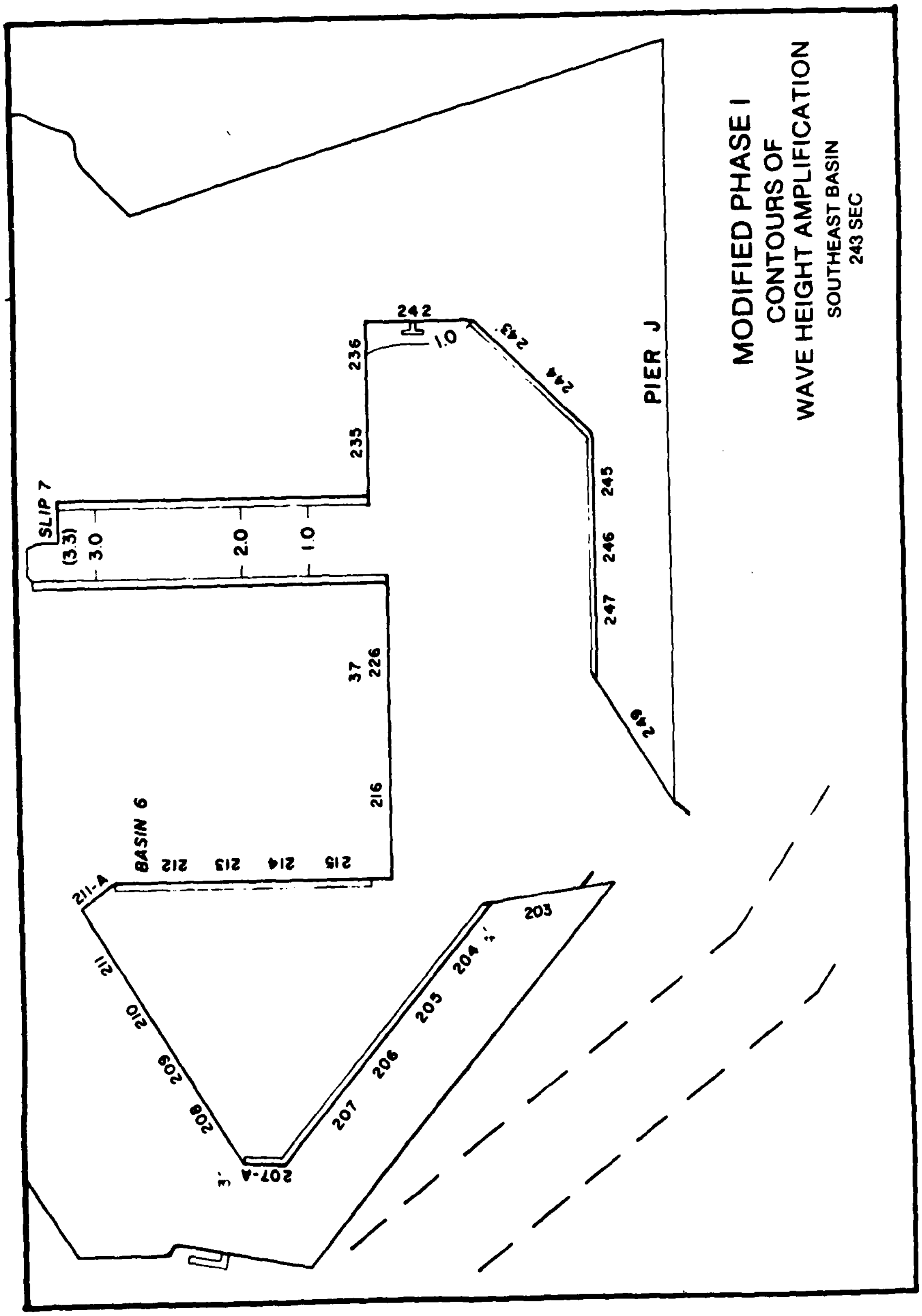

MODIFIED PHASE I
CONTOURS OF
WAVE HEIGHT AMPLIFICATION
SOUTHEAST BASIN
78 SEC
PIER J
SLIP 7
BASIN 6
242
243
244
245
246
247
249
236
235
226
216
215
214
213
212
211-A
211
210
209
208
207-A
207
206
205
204
203
(2.9)
3.0
2.0
1.0

PLATE 81



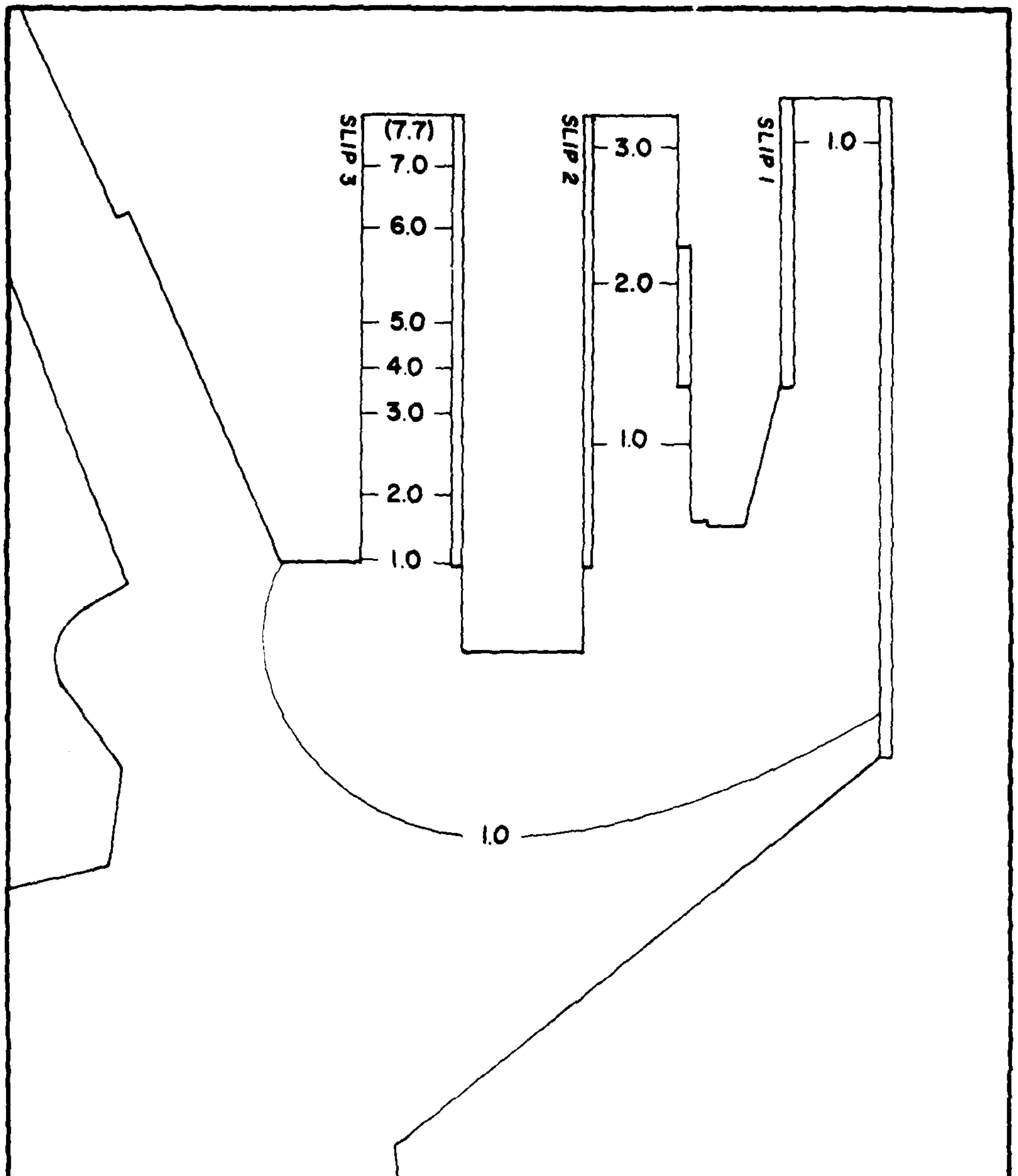
MODIFIED PHASE I
CONTOURS OF
WAVE HEIGHT AMPLIFICATION
SOUTHEAST BASIN
88 SEC


1.0
(1.7)
(1.7)
1.0
1.0
207-A
207
206
205
204
203
2.0
216
3.0
3.0
249
2.0
1.0
1.0
2.0
3.0
4.0
242
PIER J
MODIFIED PHASE I
CONTOURS OF
WAVE HEIGHT AMPLIFICATION
SOUTHEAST BASIN
153 SEC

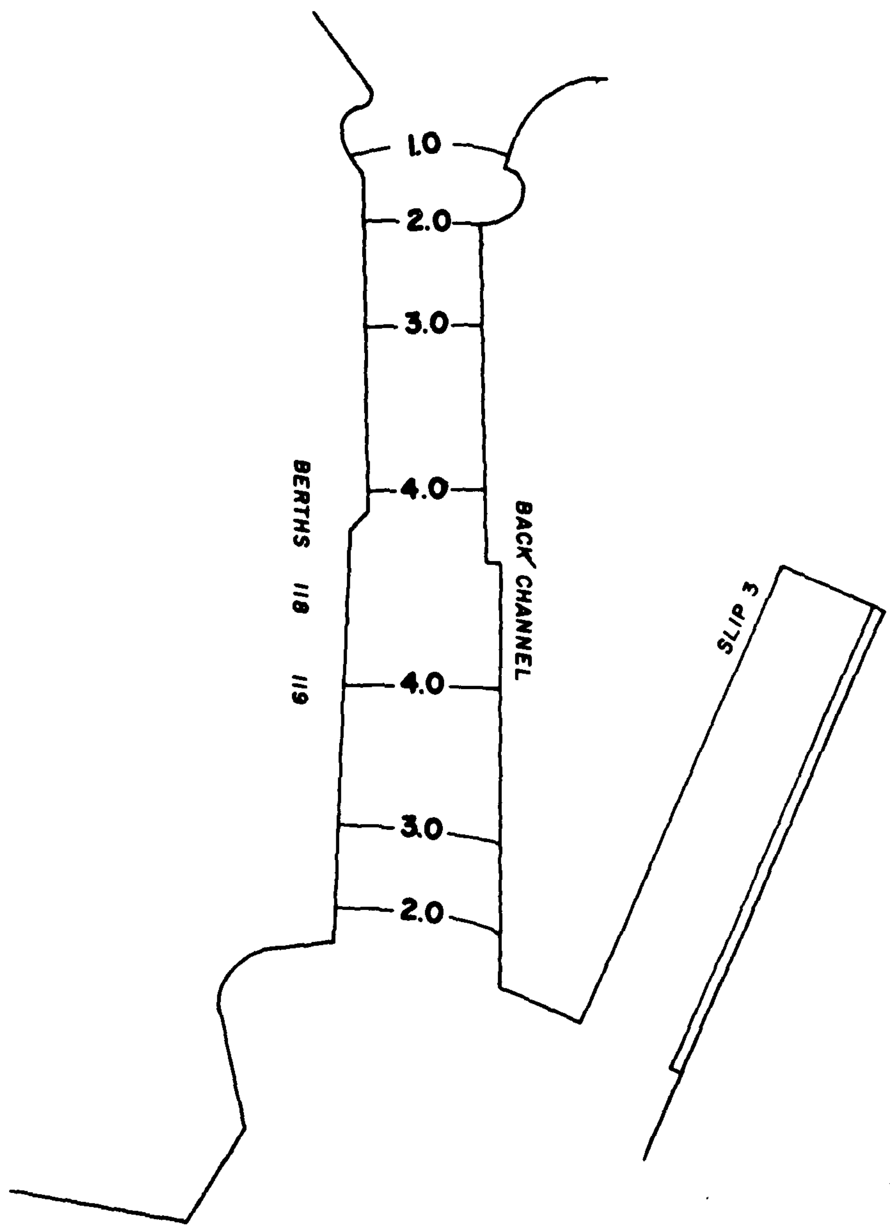


MODIFIED PHASE I
CONTOURS OF
WAVE HEIGHT AMPLIFICATION
SOUTHEAST BASIN
243 SEC
PIER J
SLIP 7
BASIN 6
(3.3)
3.0
2.0
1.0
1.0
203
204
205
206
207
207-A
208
209
210
211
211-A
212
213
214
215
216
226
235
236
242
243
244
245
246
247
249

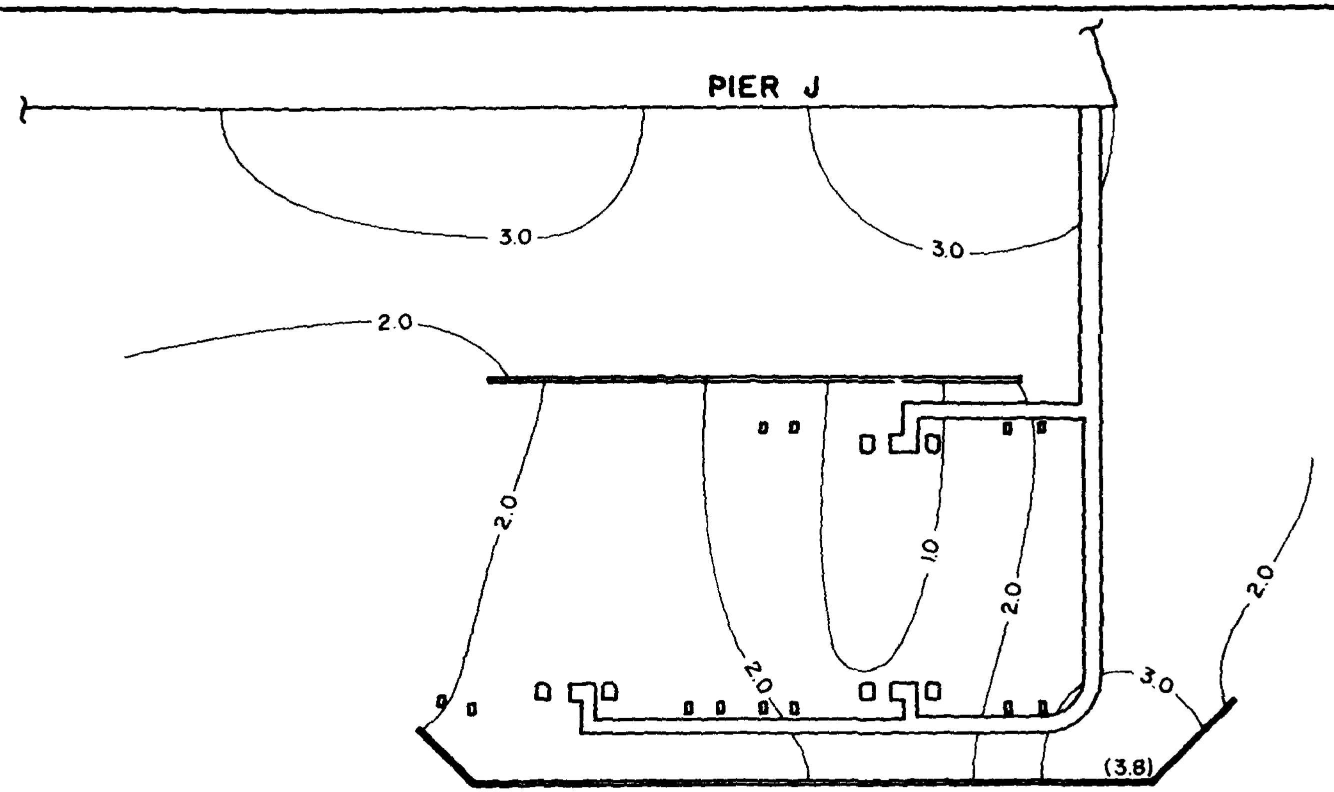
PLATE 84



MODIFIED PHASE I
CONTOURS OF
WAVE HEIGHT AMPLIFICATION
EAST BASIN
218 SEC



MODIFIED PHASE I
CONTOURS OF
WAVE HEIGHT AMPLIFICATION
BACK CHANNEL
203 SEC



MODIFIED PHASE I
CONTOURS OF
WAVE HEIGHT AMPLIFICATION
OIL TERMINAL
WITH 2000 FT DIKE
96 SEC

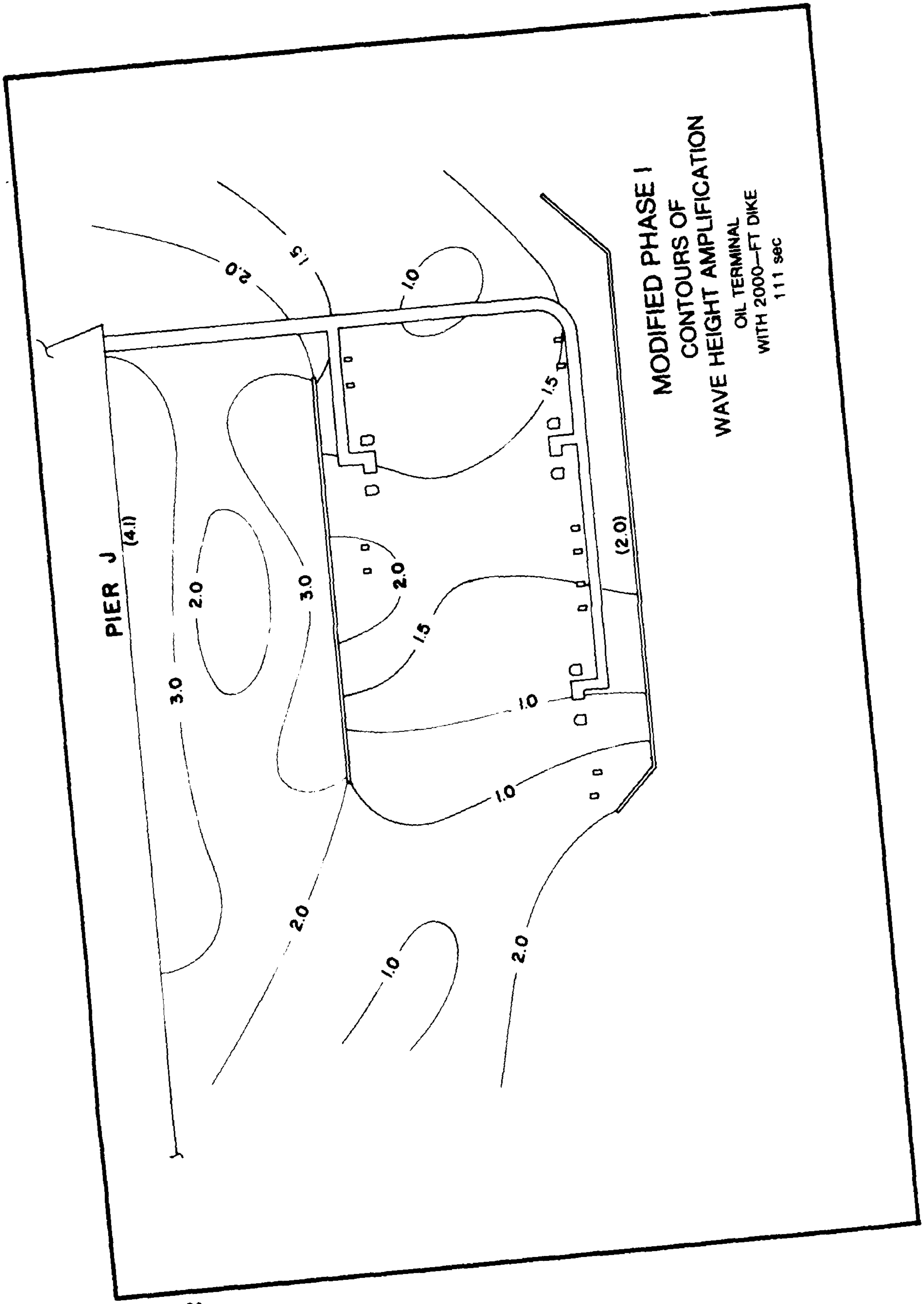
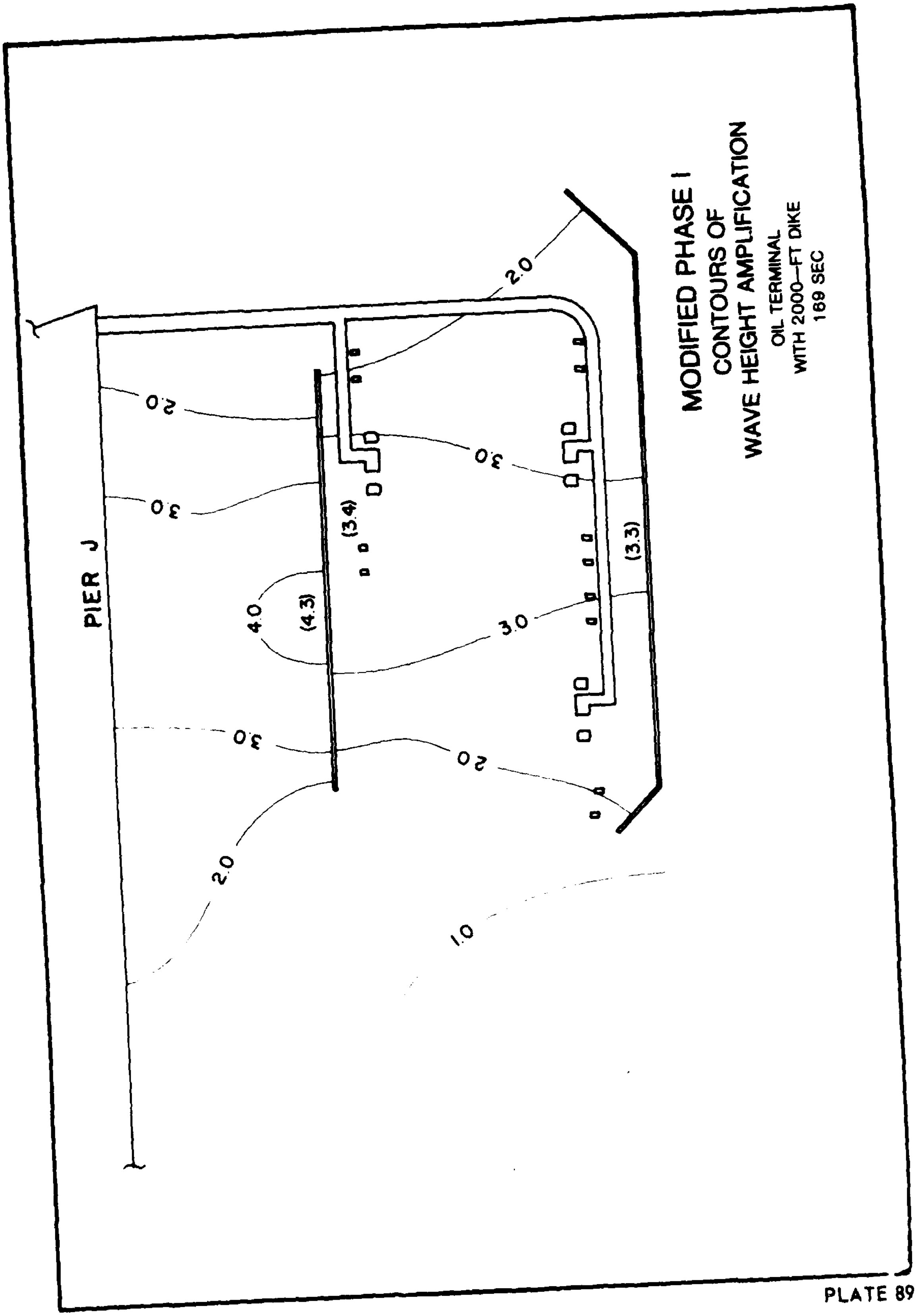

MODIFIED PHASE I
CONTOURS OF
WAVE HEIGHT AMPLIFICATION
OIL TERMINAL
WITH 2000—FT DIKE
111 sec
PIER J
(4.1)
(2.0)
3.0
2.0
1.5
1.0

PLATE 88


MODIFIED PHASE I
CONTOURS OF
WAVE HEIGHT AMPLIFICATION
OIL TERMINAL
WITH 2000—FT DIKE
169 SEC
PIER J
2.0
3.0
4.0
(4.3)
(3.4)
(3.3)
1.0

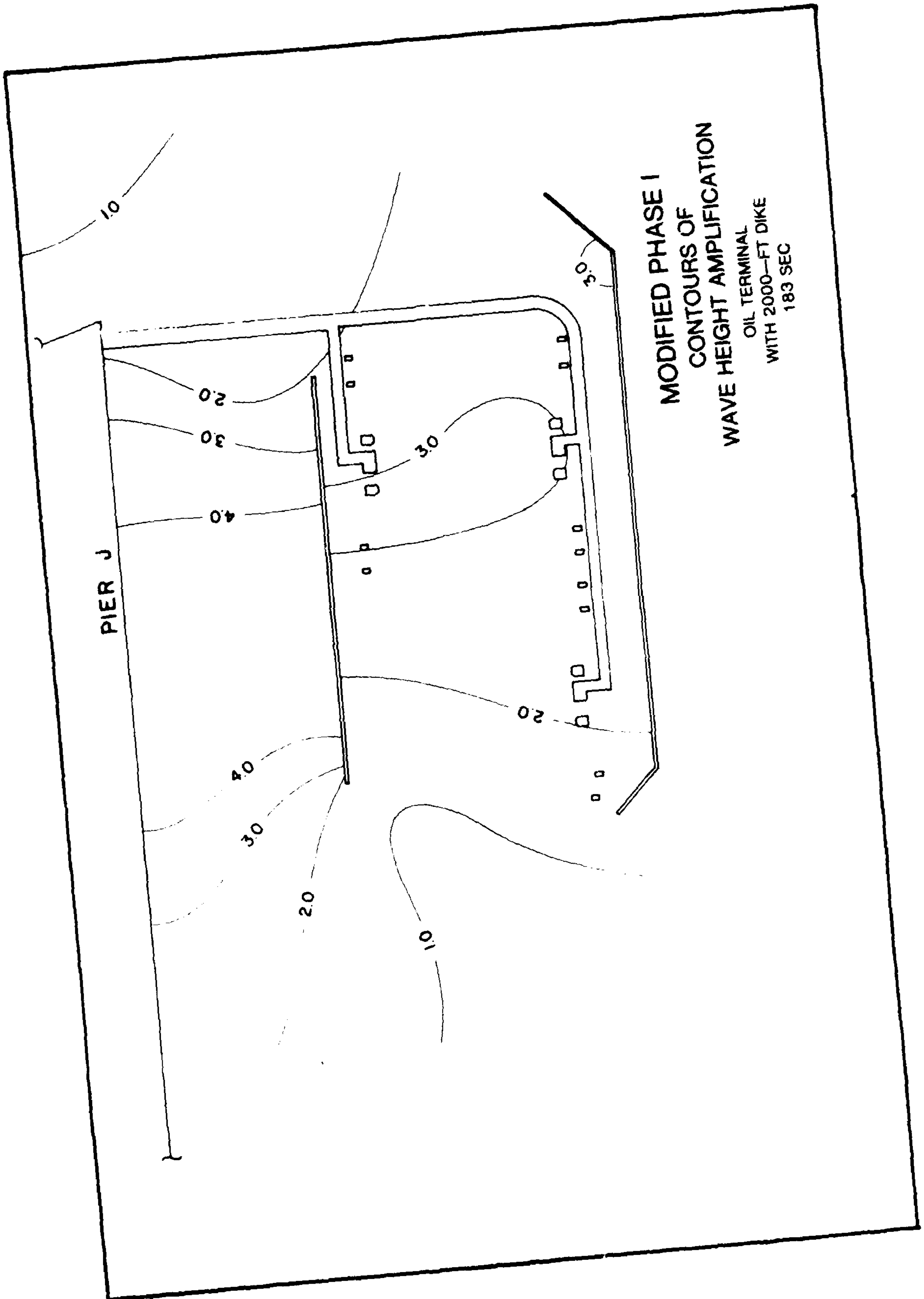
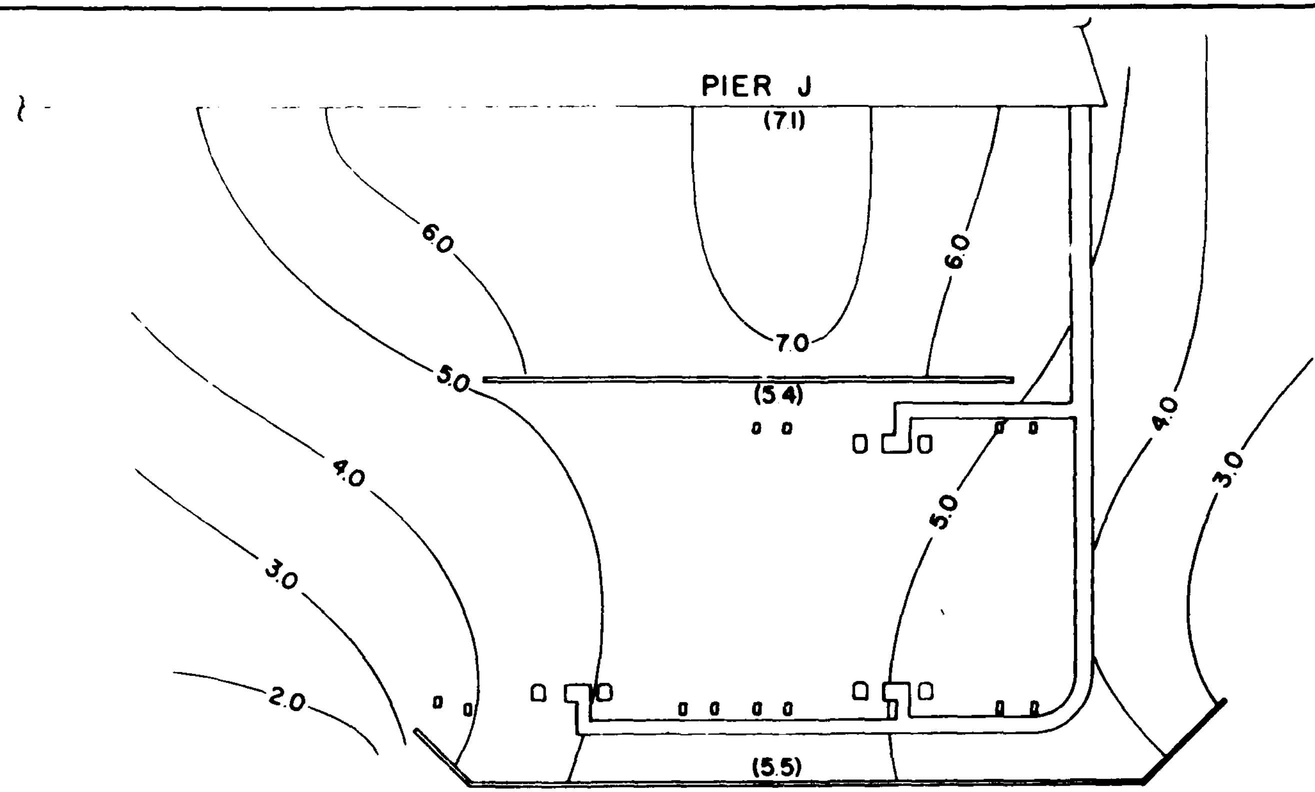

MODIFIED PHASE I
CONTOURS OF
WAVE HEIGHT AMPLIFICATION
OIL TERMINAL
WITH 2000—FT DIKE
183 SEC
PIER J
1.0
2.0
3.0
4.0
3.0
4.0
2.0
4.0
3.0
2.0
1.0
3.0

PLATE 90



MODIFIED PHASE I
CONTOURS OF
WAVE HEIGHT AMPLIFICATION
OIL TERMINAL
WITH 2000—FT DIKE
295 SEC

APPENDIX A: NOTATION

h_m	Model depth of the inner harbor
H_i	Incident wave height
H_m	Model wave height
H_r	Vertical scale ratio
H_s	Significant wave height
H_w^M	Model generated wave height
H_w^P	Prototype generated wave height
K_r	Refraction coefficient
$K_s^{M,G}$	Model shoaling coefficient at the gage locations
$K_s^{M,W}$	Model shoaling coefficient at the wave generator
$K_s^{P,A}$	Prototype shoaling coefficient at the initial refracted wave front
$K_s^{P,G}$	Prototype shoaling coefficient
$K_s^{P,W}$	Prototype shoaling coefficient at wave generator
ℓ_{hm}	Horizontal length scale in the model
ℓ_{hp}	Horizontal length scale in the prototype
L_m	Model wavelength
R	Wave-height amplification factor
T_m	Model wave period
T_p	Prototype wave period
Ω	Distortion

APPENDIX F

GEOTECHNICAL INVESTIGATIONS

CONTENTS

PLATES

APPENDIX F

GEOTECHNICAL INVESTIGATIONS

1. GENERAL. This appendix presents a summary of the geologic conditions and materials properties pertinent to the channel deepening in Los Angeles Harbor. A more detailed description of the topography, seismicity, mineral resources and other general geologic features are presented in the Final Environmental Statement dated October 1974, and the accompanying Supplemental Environmental Impact Statement. Included in this appendix are descriptions and results of the exploration, testing and analyses of representative materials of the harbor floor which will be encountered by the proposed dredging. The Port of Los Angeles is conducting a design analysis of the disposal area. The design will be reviewed for structural stability before inclusion in the Corps' contract.

2. GEOLOGY. Los Angeles harbor is located at the eastern toe of the Palos Verdes Hills in San Pedro Bay. The hills are a structural block elevated by movement along the Palos Verdes fault. The fault extends along the northeast side of the hills and continues offshore for at least 30 miles. It crosses the project area in a zone roughly one-half mile wide; the main shear appears to extend across West Basin, under the Vincent Thomas bridge and on to the southeast to exit the harbor near the entrance in the federal breakwater. Because movement of the fault

has elevated the land southwest of it, Tertiary age bedrock is exposed in the hills and also in the harbor floor adjacent to Reservation Point. Bedrock outcrops in the Main Channel south of the Coast Guard Station are the roots of the former Deadman's Island. The bedrock is a very stiff to hard overconsolidated clay-shale. Two formations, the Malaga mudstone and the Repetto siltstone, have been identified on the basis of their microfaunal assemblages. These two late Tertiary formations are overlain on their flanks by Pleistocene age compact sand and silty sand units, the Timms Point silt, the San Pedro formation and the Palos Verdes sand. All of these units have been sheared and warped to some extent, by movement on the Palos Verdes fault, then eroded. Recently deposited sands, clays and silts with a few isolated patches of gravel cover the harbor floor where the bedrock is not exposed. These sediments vary in thickness from less than one foot over the bedrock to hundreds of feet northeast of the Palos Verdes fault. The limits of the exposed mudstone and siltstone within the proposed dredging depth are shown on plate 4. The proposed channel deepening will encounter the clay-shale bedrock, the unconsolidated sediments, including the Palos Verdes sand and a surface veneer of loose sediment. Since dredging of the bedrock will be considerably more difficult and costly than the unconsolidated sediments, special attention was given to defining the limits and the nature of the bedrock units during exploration.

3. **EXPLORATION.** Exploration of the materials to be dredged within the project area consists of vibratory core drilling (vibracore) and

geophysical surveys. Two investigations were conducted; a preliminary investigation in the spring and summer of 1977, and a detailed investigation from the fall of 1977 to the spring of 1978. A third investigation with the vibracore was conducted in August 1978 to more accurately define the materials in select areas. A brief investigation consisting primarily of standard penetrometer tests will be conducted prior to the preparation of plans and specifications. These tests will be used to evaluate the dredgability of representative materials through their relative density and consistency.

Initially, a geophysical survey was conducted in April 1977, in the Outer Harbor, Main Channel and West Basin for a total length of about 16 statute miles. The survey consisted of 2 parts, "boomer" sub-bottom profiling and side-scan sonar. See plate 2, sheet 1 for location of the survey lines. The profiling identified the contact between surficial unconsolidated sediments and underlying bedrock in areas where bedrock exists at depths of less than about 125 feet. Outside of these areas, the contacts between units of the unconsolidated sediments are somewhat irregular indicating surficial materials are softer and may be discontinuous lagoonal and channel fill deposits. The side scan sonar provided a quasi-three-dimensional map view of seafloor topography and objects on the floor within approximately 100 feet each side of the survey line. An analysis of the sonar records is not included in this design memorandum but is presented in the Supplemental Environmental Impact Statement accompanying this report.

In July 1977, 6 vibracore holes were drilled in the Main Channel and turning basins to determine the general characteristics of the bottom materials and the bedrock. Cores were obtained to depths of 14 to 20 feet in the unconsolidated sediments and 2 to 6 feet into the bedrock. The locations of the vibracore holes are shown on sheets 1 and 2 of plate 1. The 2-1/2-inch diameter cores were sampled generally at 3-foot intervals for both mechanical and chemical analyses. Samples obtained for chemical testing (bottom sediment analysis) were immediately refrigerated to preserve the in-situ condition of the heavy metals (lead, zinc, mercury and cadmium) and oil and grease. The refrigerated samples were tested in the South Pacific Division Laboratory (SPD) for the chemicals and also for grain size distribution. Duplicate un-refrigerated samples were sent to the Los Angeles District Laboratory for mechanical analysis only.

Prior to the second phase of vibratory core drilling, a comprehensive geophysical survey was conducted over the project area for a total length of about 26 miles in November 1977. For location of the survey lines, see sheet 2 of plate 2. No geophysical surveys were made of the disposal site or the southern half of the existing Main Channel in the outer harbor. This survey consisted of "boomer" profiling and side-scan sonar, similar to that of the first survey, in addition to very-high resolution "pinger" profiling. The pinger records provided greater detail of the upper 25 feet of the unconsolidated sediments within the

harbor. A fathometer was used in conjunction with the surveys to help define the depth of the harbor floor on the profiles. An electronic positioning system was also used with the surveys to locate individual "fix" points, especially in the outer harbor. Where landmarks were nearby in confined areas such as the Main Channel, "dead-reckoning" was frequently employed for positioning.

In March 1978, 56 vibracore holes were drilled in the project area, exclusive of the disposal site. The location of the test holes are presented on sheets 1 and 2 of plate 1. Twenty-four of the holes were drilled in the Main Channel and entrance channel near Reservation Point in order to sample the bedrock and define its areal extent, see plate 1, sheet 2. The holes penetrated the bedrock 1.2 to 10.2 feet; most bottoming at a depth of about elevation -45 feet MLLW or greater. Of the remaining 32 holes, all but 4 were drilled through the unconsolidated sediments to depths in excess of -50 feet MLLW. The unconsolidated sediments in the core were composite sampled generally in 3-foot increments with selected shorter intervals where significant materials changes occurred. Since the proposed dredging depth is -47 feet MLLW few samples were obtained for testing below that depth except in the Outer Harbor where the dredging will extend to -53 feet MLLW. Normally, duplicate samples were obtained; one was used for grain size analysis and the other for bottom sediment analysis; the latter were refrigerated immediately upon retrieval. The mechanical analyses were performed at the Corps of

Engineers, Los Angeles District soils laboratory. All samples were tested for grain size distribution and Atterberg limits where applicable. Refrigerated duplicate samples containing more than 12 percent material passing the number 200 sieve were sent to Morningstar Laboratories, Los Angeles, for bottom sediment analysis. Cores of the bedrock were sampled at each end for micro-paleontological examination and the remainder was sealed in the vibracore liner and retained for future inspection. No samples were obtained for bottom sediment and mechanical analyses of the bedrock nor for bottom sediment analysis of the unconsolidated sediments in the Outer Harbor at this time. Logs of the holes with the mechanical and chemical test data are presented in plate 5, sheets 1 through 4.

Additional vibracore drilling was conducted in late August 1978. Thirty holes were drilled in selected locations throughout the project area including 7 holes in the proposed disposal area. Of the remaining 23 holes, 7 were drilled in the bedrock to better define its limits and 16 were drilled in the unconsolidated sediments in the Main Channel and in several slips. Locations of these holes, numbered 78-57 through 78-86 are shown on plate 1, sheets 5 and 6, and on plate 4. The drilling and sampling techniques were similar to those used in March 1978. Samples for bottom sediment analysis were tested at the Corps of Engineers, South Pacific Division Laboratory and mechanical analyses were conducted at the Los Angeles District Soils laboratory. The logs and testing data are presented on plate 5, sheets 6 and 7.

4. TESTING

a. Mechanical Analysis. A mechanical analysis was made on each sample of the unconsolidated sediments above -47 feet MLLW and above elevation -53 feet MLLW in the outer harbor. Random samples of the clay-shale bedrock from the 1977 drilling were also tested. The mechanical analysis determined the grain size distribution of the material in which the percentages by weight of the materials passing each sieve of the No. 10, 40, 60, 100 and 200 sizes were measured. The samples containing more than 12 percent material passing the No. 200 sieve were also tested for Atterberg limits in order to determine the clay and silt classifications.

b. Chemical Analysis. All unconsolidated sediment samples containing more than 12 percent material passing the No. 200 sieve and a few bedrock samples were tested for heavy metals (mercury, lead, zinc and cadmium) and oil and grease. Since acceptable pollution limits for landfill disposal of dredged material have not been specifically established, EPA, region IX, criteria for beach replenishment were used in order to establish a baseline for the evaluation of the level of pollutants in the materials. The EPA criteria for maximum acceptable polluted dredge material levels in beach material is presented as note 5 on sheet 1 of plate 5.

The SPD laboratory and Morningstar Laboratory used the testing pro-

cedures described in "Preliminary Sampling and Analysis Procedures for Evaluating the Disposal of Dredged Materials," by the Environmental Protection Agency, Region IX, April, 1974. Oil and grease was extracted using the hexane process, mercury by the cold vapor technique and all other elements were determined by atomic absorption.

c. Unconfined Compressive Testing. Approximate strengths of the clay-shale bedrock were obtained on random samples using a pocket penetrometer. The tests were performed on the ends of the 2-1/2-inch diameter cores while still in the vibracore liners.

d. Bedrock Dating. Samples of the bedrock and microfauna extracted from it were inspected by a paleontologist from California State University at Long Beach.

5. ANALYSIS. Evaluation of the data from the exploration indicate that two basic categories of materials will be involved in the proposed dredging, clay-shale bedrock and unconsolidated sediments including a surface layer of muck. The geophysical boomer profiles shown on plate 5 graphically present the layering below the harbor floor. Each of the categories is described with their extent and dredgability in the following paragraphs.

a. Bedrock. The clay-shale bedrock exists within the project limits and required depth of excavation approximately from the Coast

Guard station on Reservation Point southeast one mile to about buoy "4" in the Outer Harbor. Plate 4 shows the approximate extent of bedrock to be excavated within the project depth. The bedrock testing indicate the material is composed of two formations, the Malaga mudstone of upper Miocene age and the Repetto siltstone of upper Miocene to lower Pliocene age. The physical properties of each, however, are virtually identical and the 2 formations will be treated as one unit in this report. Penetration of the bedrock with the vibracore was consistently difficult and it could not be cored deeper than 12.0 feet; average depth of penetration was 5.7 feet. This penetration resistance along with the results of the pocket penetrometer tests presented in Table 1 indicate that the clay-shale is very stiff to hard and will be difficult to dredge.

TABLE I

UNCONFINED COMPRESSIVE STRENGTH OF CLAY-SHALE

Hole No.	Depth (feet)	Strength* (tons/square foot)
78-33	1.0	3.5+
78-33	6.1	4.3
78-42	9.2	3.5
78-43	1.7	3.4
78-43	4.2	3.6
78-48	6.0	4.1
78-48	12.4	4.0
78-54	6.0	4.0
78-54	15.2	3.3
78-55	2.2	2.4
78-55	4.1	3.4

* by pocket penetrometer

The material is generally massive with occasional vague bedding, brownish-black in color and relatively uniform in its physical characteristics. Where tested, the bedrock broke down to a highly plastic clay with liquid limits ranging from 76 to 116 and plasticity indexes from 45 to 65. Test results from three bedrock samples indicate the pollutants concentration in the clay-shale is low. Based on the maximum acceptable limits for beach replenishment (See note 5 on sheet 1 of plate 5), the level of oil and grease is 10 percent of maximum, zinc is 62 percent, lead is 7 percent, mercury is less than one-half percent and cadmium is 47 percent. One known pocket of unconsolidated sediment exists within the bedrock area. This pocket is approximately 200 feet in diameter containing clean and coarse sand. Test hole 78-62 encountered the pocket which is also visible on seismic profile line 3X (see plate 3). It is anticipated that the pocket extends towards the north possibly outside the dredging limits.

b. Unconsolidated Sediments. The unconsolidated sediments comprise the bulk of the harbor to be excavated. The sediments are divided into two groups, those occurring naturally which were deposited throughout San Pedro Bay prior to development of the harbor and the surface sediments which have been deposited in the various channels and basins since they were last dredged. The natural sediments are composed of sands, silts and clays, all in varying combinations; the predominating material is silty sand. The surface sediment is generally a soupy and

very soft muck consisting of clay and silt with minor amounts of sand. The following paragraphs will discuss the two groups.

(1) Natural sediments. In general, the natural sediments range in thickness from zero to hundreds of feet and in the Outer Harbor are relatively continuous. North of about berth 90, the upper strata occur in irregularly shaped bodies suggesting the erosion of channels in the harbor floor with subsequent deposition of a different material as would occur in a lagoonal environment. The West Basin within the project depth contains mostly silty sand and lean clay in irregularly shaped lagoonal deposits. Towards the north end of West Basin, the amount of sand increases and becomes cleaner, but deposits of fat clay are also present. In the East Basin and East Channel mostly silts and clays occur with a few stringers of silty sand. From the lower end of the East Channel, sand to silty sand extends into the eastern half of the Turning Basin and down to the Vincent Thomas Bridge. South of the bridge to about berth 92, deposits in the Main Channel appear to become more irregularly shaped, consisting of lenses of lean clays interbedded with sands. Further south to the bedrock contact extending from berth 72 across the channel to the Coast Guard Station, sand and silty sand strata predominate with scattered interbeds of silt and clay, see plate 4. The drilling indicates clays and silts occur along the west side of the channel between berths 92 and 82 but the geophysical data and borings taken by the Port of Los Angeles

indicate predominantly sand is present. The Port has recently dredged the eastern two thirds of the reach between berths 92 and 82 to -47 feet MLLW to backfill slip No. 232. Most of the sand south of about berth 73 is a portion of two Pleistocene age formations, the Palos Verdes sand and the San Pedro formation which outcrop in the harbor floor as a band between the clay-shale bedrock and the adjoining unconsolidated sediments. These formations contain the cleanest and most coarse sand of all the strata to be dredged. Median grain sizes range mostly from 0.33 to 0.39 mm with intervals to 1.2 mm. The geophysical data indicate the Palos Verdes sand and the San Pedro formation extend to at least a 125-foot depth with few clay or silt lenses. From a line, in the Outer Harbor extending roughly between buoy "3" and buoy "4" out to the breakwater, the dredging will encounter mostly sandy silts and silty sands interbedded with some silts and clays. One reach about 300 yards long from about test hole 77-1 towards test hole 77-2 consists mostly of silt with both fat and lean clay strata. One pocket of coarse sand, roughly 200 feet across, exists in the bedrock spanning test hole 78-62. Because of the deeper water in the Outer Harbor, the quantity of materials to be dredged in this zone is relatively small. Table II presents the median grain size of the predominantly sand layers in all holes where encountered and tested except in the disposal area. Holes and strata not listed have median grain sizes less than 0.074 mm (No. 200 sieve).

TABLE II

MEDIAN GRAIN SIZE OF SAND INTERVALS

Test Hole No.	Depth (feet)	Median Grain Size (D50-mm)	Test Hole No.	Depth (feet)	Median Grain Size (D50-mm)
77-2	1	0.1	78-27	0-2.8	0.33
77-2	4	0.09	78-27	2.8-5.8	0.39
77-6	2	0.49	78-27	5.8-8.8	0.60
77-6	6	2.3	78-28	0-3	0.35
77-6	10	0.95	78-28	3-6	0.31
78-1	0-3	0.08	78-28	6-10	1.2
78-2	7-11	0.14	78-16	6-9.5	0.21
78-4	5.6-8.1	0.55	78-18	0-2	0.11
78-11	15.7-16.7	0.13	78-19	0-2	0.14
78-12	5.5-9	0.19	78-21	0-3	0.15
78-12	9-12	0.23	78-21	3-6	0.19
78-13	0-3	0.20	78-21	6-9	0.25
78-13	3-6	0.20	78-21	9-12	0.19
78-13	6-10	0.22	78-29	0-2.9	0.25
78-15	0-3	0.15	78-29	2.9-5.5	0.25
78-15	3-6	0.25	78-29	5.5-8.5	0.25
78-15	6-9	0.10	78-31	4.4-6.8	0.28
78-15	11-12.8	0.12	78-45	0-3.1	0.42
78-16	0-3	0.16	78-45	3.1-6.1	0.25
78-16	3-6	0.16	78-45	6.1-11.4	0.11
78-5	0-1.6	0.08	78-57	0-2.6	0.25
78-5	3.5-7	0.11	78-57	2.6-6.2	0.10
78-8	4.2-8	0.11	78-57	13.6-16.4	0.16
78-8	8-12	0.11	78-62	0-3.1	0.18
78-9	0-3.6	0.16	78-62	3.1-4.0	0.50
78-10	0-3	0.12	78-62	4.0-7.0	0.35
78-10	3-6	0.16	78-62	7.0-9.3	0.35
78-10	6-9	0.11	78-62	9.3-10.9	0.50
78-22	0-3.1	0.14	78-63	0-1.0	0.25
78-22	3.1-7.5	0.17	78-70	0-3.3	0.12
78-23	7.4-11	0.08	78-74	3.6-7.0	0.35
78-26	4.8-8.6	0.25	78-74	7.0-10.0	0.50
78-26	8.6-12	0.10	78-74	10.0-12.9	0.70
78-26	12-15	0.22	78-75	6.3-11.6	1.00

TABLE II
(Continued)

Test Hole No.	Depth (feet)	Median Grain Size (D50-mm)	Test Hole No.	Depth (feet)	Median Grain Size (D50-mm)
78-75	11.6-12.9	38.5	78-80	7.0-10.8	0.17
78-76	5.3-11.0	0.25	78-80	13.5-14.3	0.30
78-76	11.0-13.0	0.38	78-81	0-5.0	0.42
78-76	13.0-15.6	0.08	78-81	5.0-10.0	0.35
78-76	15.6-20.1	0.30	78-81	10.0-15.0	0.36
78-77	0-4.0	0.28	78-81	15.0-19.5	0.36
78-77	4.0-8.1	0.37	78-82	3.4-7.2	0.14
78-77	15.0-17.5	0.17	78-83	5.9-8.9	0.09
78-77	17.5-20.0	0.28	78-83	11.4-14.3	0.38
78-78	4.5-7.1	0.20	78-83	14.3-15.4	1.80
78-78	7.1-12.0	0.20	78-84	2.2-6.0	0.18
78-78	12.0-18.9	0.25	78-84	6.0-10.0	0.15
78-78	18.9-20.0	0.09	78-84	10.0-13.3	0.18
78-79	0-2.6	0.18	78-84	13.3-15.9	0.12
78-79	2.6-6.0	0.16	78-85	0-3.0	0.10
78-79	6.0-10.0	0.12	78-85	3.0-5.7	0.29
78-79	10.0-13.0	0.12	78-85	5.7-9.0	0.11

Results of the bottom sediment analyses of the natural unconsolidated sediments excluding the surface muck, indicate that the heavy metals and oil and grease concentrations in these materials are all very low as compared with the maximum limits for beach replenishment. The silts and clays tend to possess larger pollutant concentrations than the coarser sediments. However, the greatest concentration of zinc encountered in the 1978 exploration was 52.3 ppm in a sand layer in hole 78-22. Maximum pollutant concentrations in the natural sediments for both the 1977 and 1978 exploration are as follows: oil and grease, 1370 ppm in test hole 78-19; mercury, 2.3 ppm in test hole 78-2; lead, 63.7 ppm in test hole 78-22; cadmium, 2.2 ppm in test hole 78-35; and zinc, 130 ppm in test hole 77-6.

(2) Surface Sediments. These sediments extend north from about the end of Reservation Point through all the waterways in thicknesses varying from zero to 8 feet. West Basin contains a layer of these sediments generally less than 3 feet thick, since the basin is the most recent to be dredged. In general, the deposit is thicker towards the waterway borders and thinner in the middle. This is apparently caused by ocean currents and moving ships spreading it towards the borders. The material is consistently a "soupy" and very soft muck. Its color is dark gray to brownish-black when wet, at times grading towards brown, black or gray. It consists mostly of material classifying as clay or silt with varying amounts of fine sand. Sand zones progressively increase down the Main Channel adjacent to Reservation Point; little, if any, of the soupy deposit appears to exist in the outer harbor within the project limits. The origin of the muck is primarily from sources in the inner waterways such as sewage or coagulation of materials in suspension following prior dredging of silts, clays and the bedrock. Surface runoff from storms drainage has provided additional material including sand. The boring logs indicate that where the amount of sand increases, the muck layer tends to be firmer. Along the bulkheads where the muck tends to be thickest, it contains a variable amount of scrap and trash. In areas such as the East Channel, much of the hidden trash is likely metal from salvage and scrap operations.

(3) Because of its recent origin, fine particle size and exposure on the harbor floor, the surface muck contains the greatest concentration of pollutants within the project area. The concentrations are not uniform throughout the waterways, but vary considerably exceeding the EPA limits for beach replenishment in portions of the East Channel, East Basin and Main Channel. The levels of oil and grease and mercury are generally high in East Basin exclusive of areas spanning test holes 78-5 and 78-6; a very high level of lead occurs around test hole 78-4. In the East Channel, high levels of oil and grease and mercury were encountered in test hole 78-7 decreasing slightly towards test holes 78-8 and 78-22. In the Main Channel, a relatively high oil and grease concentration exists in the surface muck spanning test holes 78-25 and 78-28. Excessive amounts of zinc and lead occur in the section between test holes 78-75 and 78-78, exclusive of test hole 78-77 and also around test holes 78-82 and 78-83. Excessive cadmium levels were encountered nowhere in the project area.

Chemicals exceeding the EPA limits for beach replenishment in the surface sediment to be dredged are as follows:

TABLE III

EXCESSIVE POLLUTANTS IN SURFACE SEDIMENT

Test Hole	Chemical	Concentration (ppm)
78-2	Oil & grease	2970
78-4	Oil & grease	2990

TABLE III

EXCESSIVE POLLUTANTS IN SURFACE SEDIMENT

Test Hole	Chemical	Concentration (ppm)
78-7	Oil & grease	4470
78-25	Oil & grease	2830
78-28	Oil & grease	2870
78-78	Oil & grease	3840
78-86	Oil & grease	7910
78-75	Zinc	267
78-76	Zinc	449
78-78	Zinc	340
78-86	Zinc	441
78-1	Mercury	1.8
78-2	Mercury	1.7
78-3	Mercury	2.4
78-7	Mercury	2.6
78-4	Lead	339
78-75	Lead	118
78-76	Lead	190
78-78	Lead	158
78-86	Lead	224

It must be noted that the zinc concentrations are consistently low in the holes drilled during March 1978, indicating that the test data for zinc may be in error.

6. SUMMARY. The estimated quantity of materials to be excavated in this project is 14.7 million cubic yards. Table III presents, for estimating purposes, the approximate quantity of each type material in the required excavation.

TABLE IV

ESTIMATED QUANTITY OF MATERIALS TO BE EXCAVATED

Material	Quantity (million cubic yards)
1. Unconsolidated sediments	
a. Surface sediment (muck)	2.6
b. Sand/silty sand (SP & SM)	5.6
c. Silt/clay (CH,MH,CL & ML)	4.0
2. Bedrock (clay-shale)	2.5
TOTAL	14.7

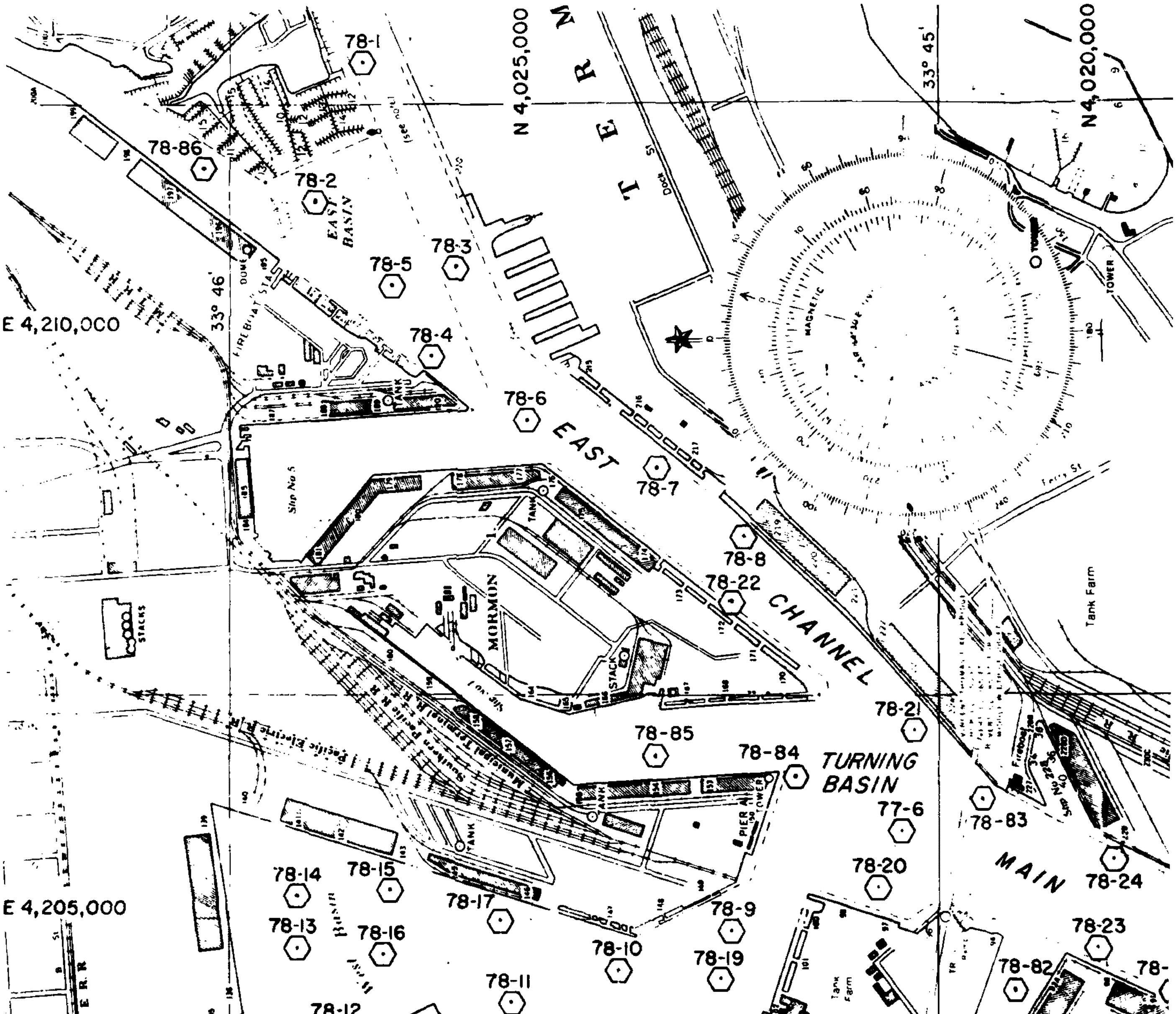
Because of the extreme variance in the materials to be excavated in the proposed channel deepening, dredging conditions will also vary. The surface sediment is soft, frequently soupy and has a high silt or clay content although some sand exists. The muck varies in thickness from zero to as much as 8 feet. It is thickest along the border of the Main Channel and East Basin and thinnest in the outer harbor and the West Basin. Bottom sediment analyses indicate the overall concentration of heavy metals (zinc, lead, mercury and cadmium) and oil and grease is very low. Where significant levels of the chemicals do occur, it is usually in the surface sediments in portions of the Main Channel and particularly in the East Channel and East Basin. In addition, dredging of this surface deposit is likely to encounter trash and scrap along the channel borders, particularly in the East Channel.

The unconsolidated natural sediments consisting of sands, silts and clays should pose little difficulty in dredging, although some of the clay strata may be a little more resistant. The level of chemical pollution in these strata is extremely low, especially in the sands, and special requirements for their disposal (outside of turbidity from the silts and clays) would not be required. Based on previous experience, channel wall cut slopes of one vertical on two horizontal should be stable.

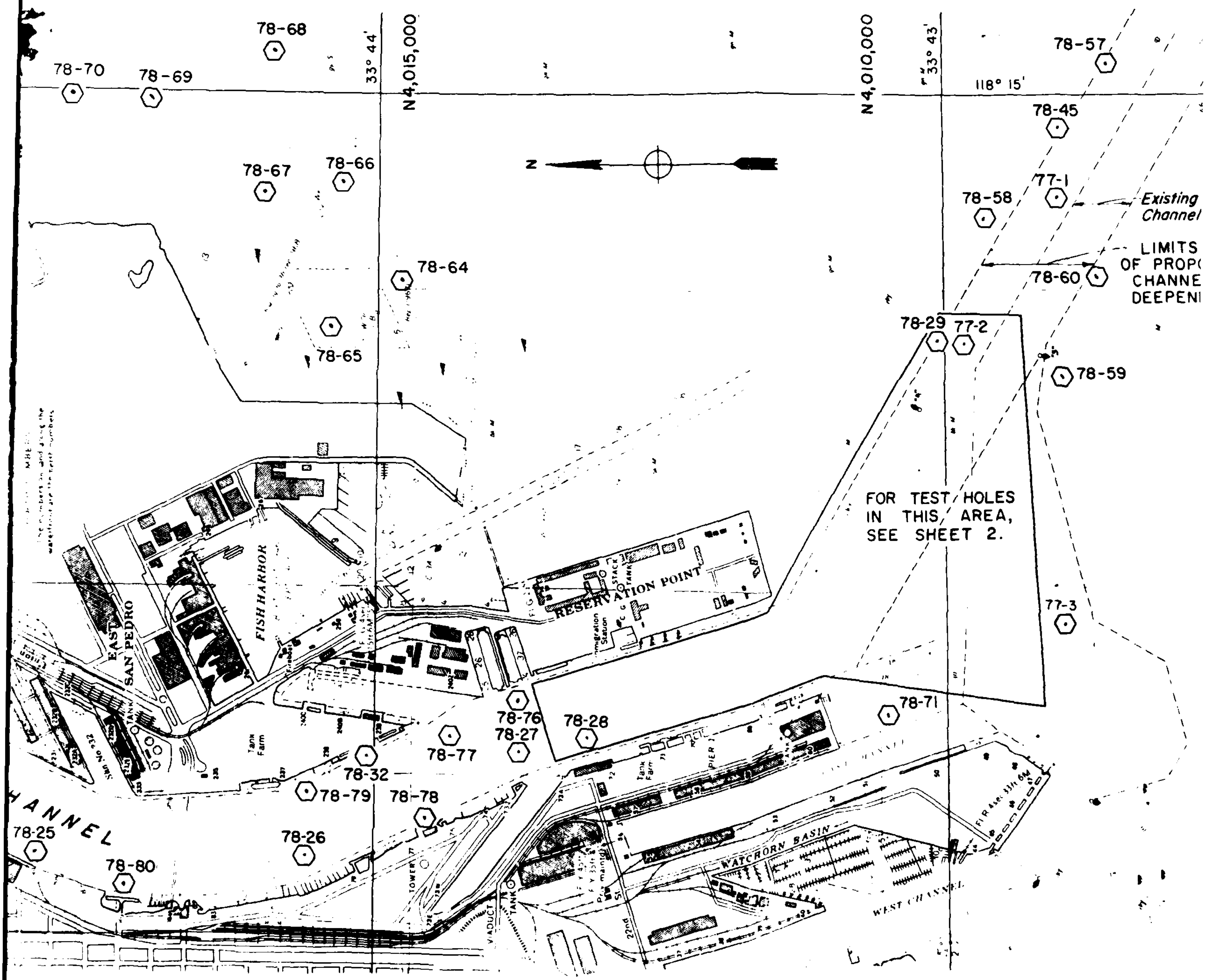
The clay-shale bedrock will be the most difficult of all the materials to dredge. The material is a very stiff and relatively massive clay which would excavate in chunks and would also cause high turbidity, especially in the disposal area. Dredging resistance of the bedrock would probably be greater in those areas off the south ends of Reservation Point and Pier One outside the existing channel. These areas require cuts of as much as 27 feet to reach elevation -47 feet MLLW. Although no test holes were drilled to the proposed grades, seismic profiling data indicate the bedrock changes little with depth. Dredging conditions in the bedrock should be consistant except for an occasional small pocket of recent sediment deposited in local depressions in the bedrock surface. In the shallower cuts up to 10 feet, vertical slopes in the bedrock should be stable. In the deeper cuts, the slopes in the bedrock should be excavated no steeper than one vertical on one-half horizontal.

During the exploratory drilling, hard inpenetrable rock was encountered at two locations, immediately off the southwest corner of Reservation Point (test hole 78-52) and adjacent to the Coast Guard Station (test holes 78-31 and 46). The rock was encountered at or just underneath the harbor floor and may be remnants of two old jetties which extended from the former Deadman's Island. If such is the case, the lateral extent of the rock will be very limited. These two areas will be further investigated prior to preparation of the plans and specifications.

Because of the variability in the excavated materials, the finer grained and more polluted portions (surface muck, trash and bedrock) should be disposed of prior to the coarser sediments and will be placed on the landward side of the fill and shall not be used as foundation for the disposal area dike. The most favorable sand deposits are towards the north side of West Basin, between Mormon Island and the Vincent Thomas Bridge and from berth 83 to the Coast Guard station in the Main Channel. The latter area is the largest and contains the best sand of the 3 locations. If more sand is required than is available within the required depth of excavation, this area may be over-excavated to considerable depths for additional material.

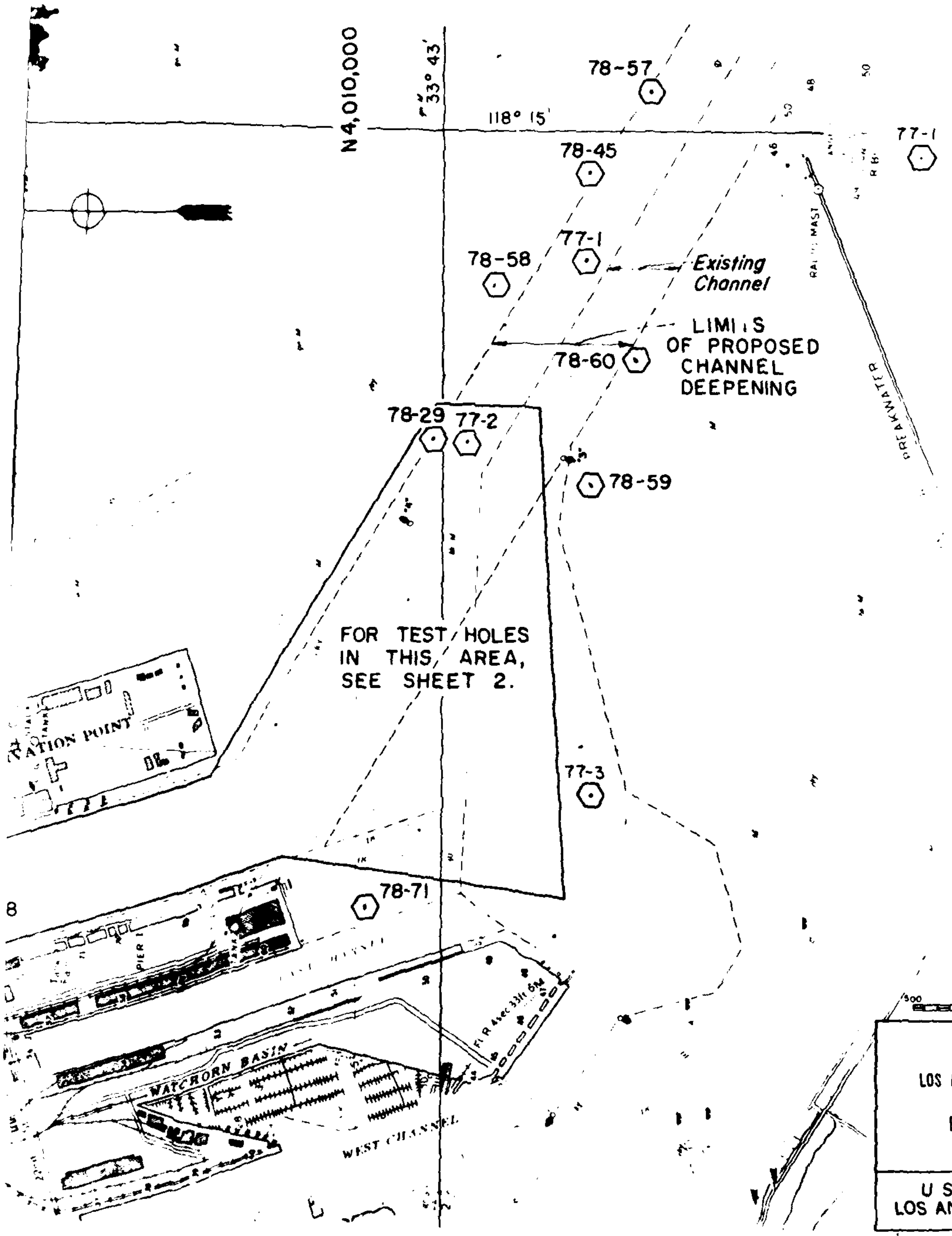


78-1
78-86
78-2
EAST BASIN
78-5
78-3
78-4
E 4,210,000
33° 46'
N 4,025,000
T E R M
Dock St
FIREBOAT STA
78-6
EAST
78-7
78-8
78-22
CHANNEL
Slip No 5
MORMON
STACKS
STACK
TANK
MAGNETIC
TOWER
Ferry St
33° 45'
N4,020,000
Tank Farm
78-85
78-84
TURNING BASIN
78-21
77-6
78-83
MAIN
78-24
PIER A
78-20
78-14
78-15
78-17
E 4,205,000
78-13
78-16
78-9
78-10
78-19
78-11
78-12
78-18
78-23
78-82
P E R R



78-68
78-70
78-69
33° 44'
N4,015,000
N4,010,000
33° 43'
118° 15'
78-57
78-45
78-67
78-66
N
77-1
78-58
Existing Channel
LIMITS OF PROPO CHANNE DEEPENI
78-64
78-60
78-65
78-29
77-2
78-59
FOR TEST HOLES IN THIS AREA, SEE SHEET 2.
FISH HARBOR
EAST SAN PEDRO
RESERVATION POINT
77-3
78-71
78-76
78-27
78-28
78-77
78-32
78-79
78-78
CHANNEL
78-25
78-26
78-80
WATCHORN BASIN
WEST CHANNEL
TANK
VIADUCT
TOWER
22nd
Tank Farm
PIER 1

2



LEGEND

77-1 VIBRACORE TEST HOLE LOCATION AND NUMBER.

NOTES

1. SEE PLATE 2 FOR LOCATION OF GEOPHYSICAL SURVEYS.
2. SEE PLATE 3 FOR LOGS OF TEST HOLES.
3. MAP TAKEN FROM U.S.C. & G.S. CHART 5147, MARCH, 1974.

SCALE IN FEET
500 0 500 1000

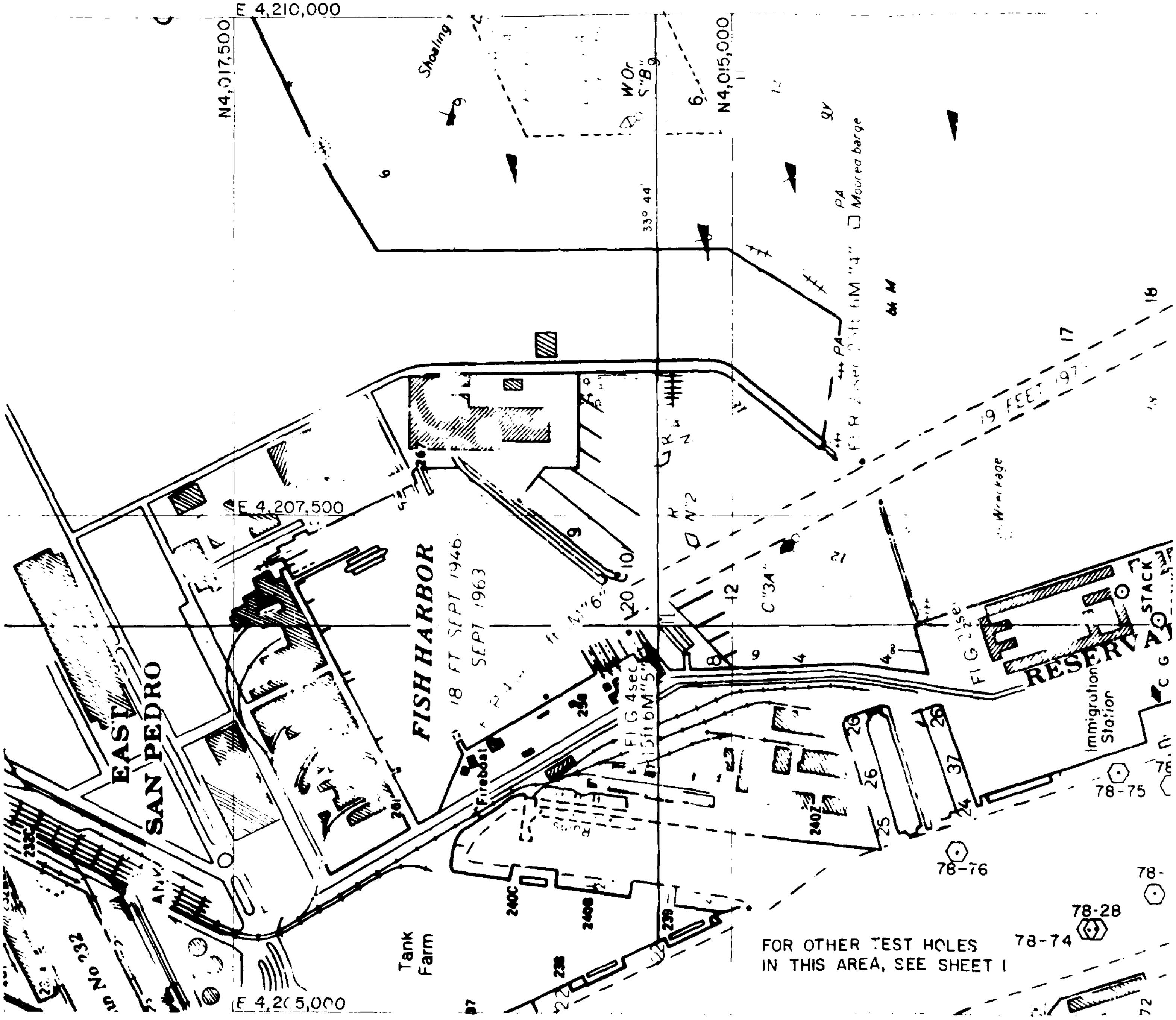
NAVIGATION IMPROVEMENT
LA-LB HARBORS, CALIFORNIA
LOS ANGELES HARBOR CHANNEL DEEPENING

PLAN OF TEST HOLES

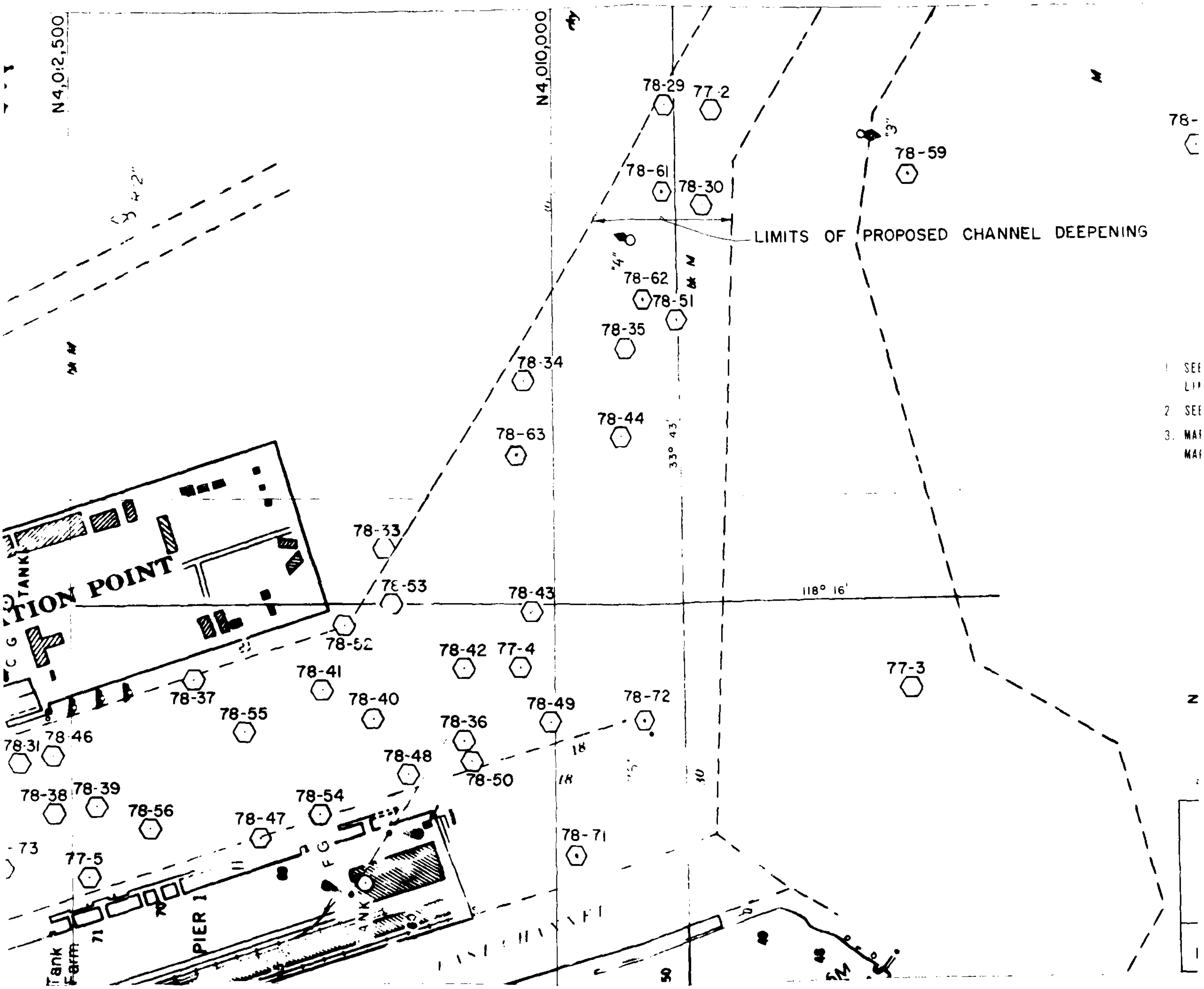
U S ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS

PLATE 1 SHEET 1

3

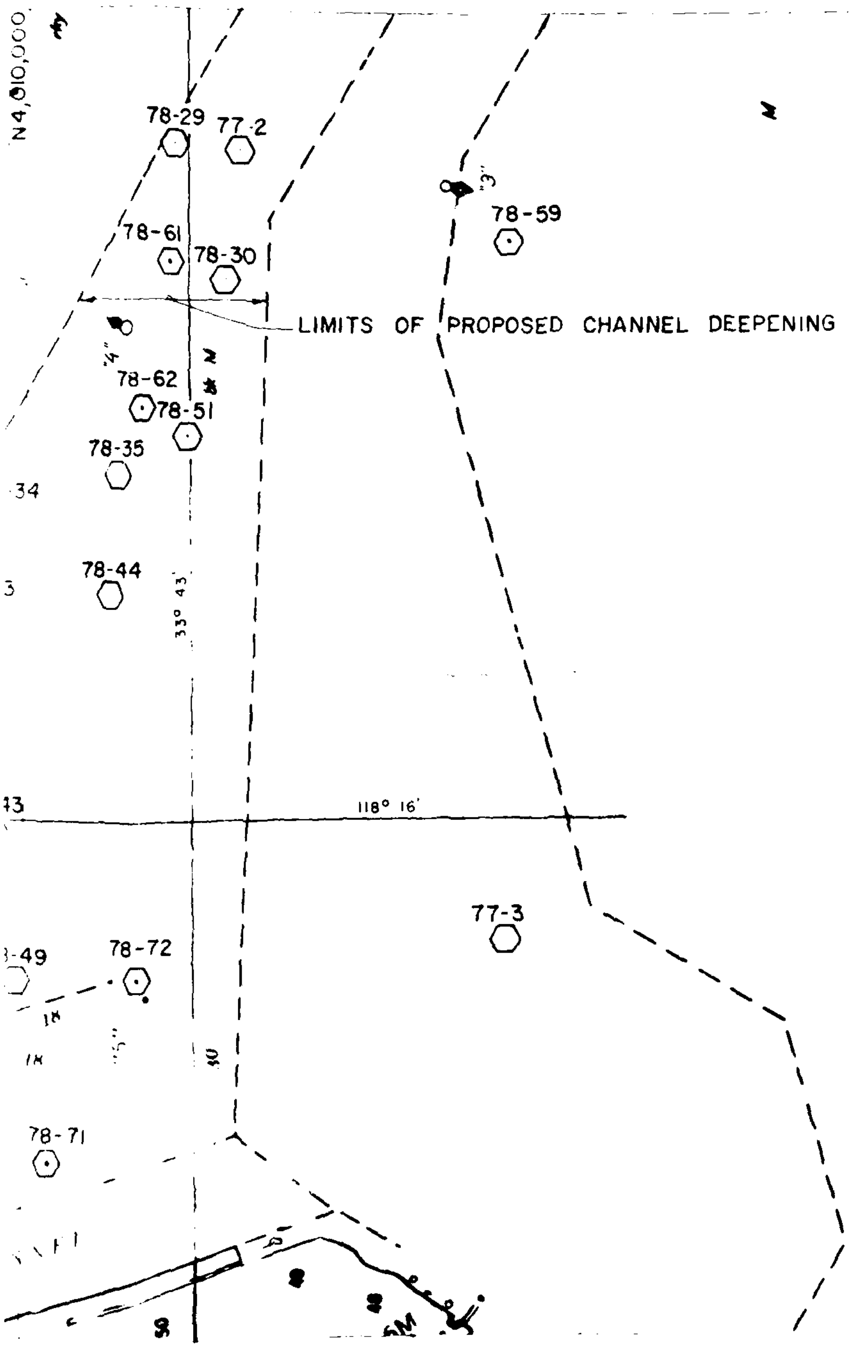


E 4,210,000
N4,017,500
N4,015,000
E 4,207,500
E 4,205,000
33° 44'
Shoaling
Moored barge
FISH HARBOR
18 FT SEPT 1946
SEPT 1963
19 FEET
Wreckage
EAST SAN PEDRO
Tank Farm
Fireboat
Immigration Station
STACK
RESERVA
78-75
78-76
78-28
78-74
FOR OTHER TEST HOLES
IN THIS AREA, SEE SHEET I



N4,012,500
N4,010,000
78-29
77-2
78-61
78-30
78-59
"3"
"4"
LIMITS OF PROPOSED CHANNEL DEEPENING
78-62
78-51
78-35
78-34
78-44
78-63
33° 43'
78-33
TION POINT
TANK
78-53
78-43
118° 16'
78-52
78-42
77-4
77-3
78-41
78-37
78-40
78-55
78-49
78-72
78-36
78-31
78-46
78-48
78-50
78-38
78-39
78-56
78-54
78-47
78-71
77-5
PIER 1
Tank Farm

2



LEGEND

78-40 VIBRACORE TEST HOLE LOCATION, NUMBER AND YEAR DRILLED

NOTES

1. SEE PLATE 2 FOR LOCATION OF GEOPHYSICAL LINES.
2. SEE PLATE 3 FOR LOGS OF TEST HOLES
3. MAP TAKEN FROM U.S C. & G.S. CHART 5147 MARCH, 1974.

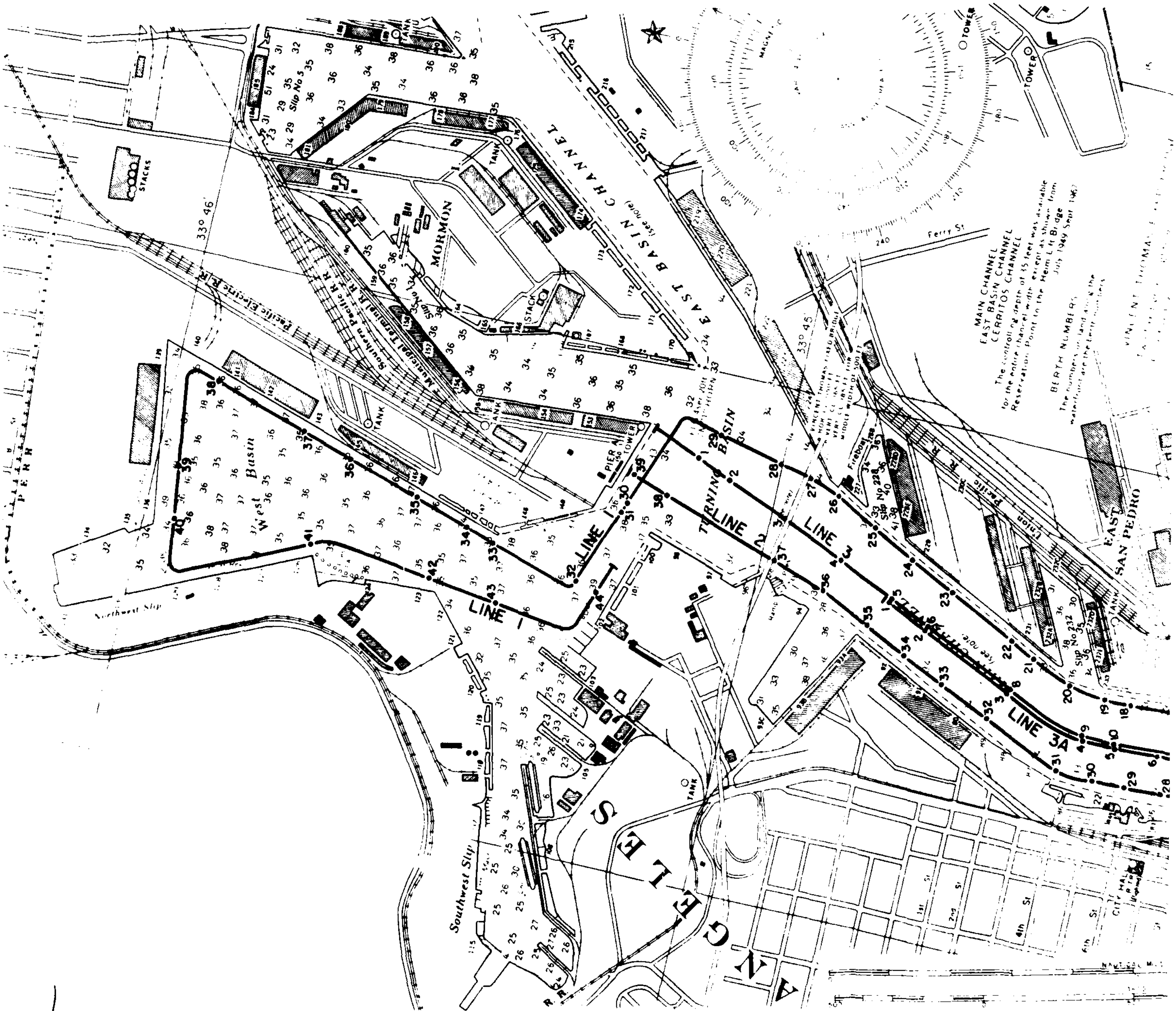
NAVIGATION IMPROVEMENT
LA-LB HARBORS, CALIFORNIA

LOS ANGELES HARBOR CHANNEL DEEPENING

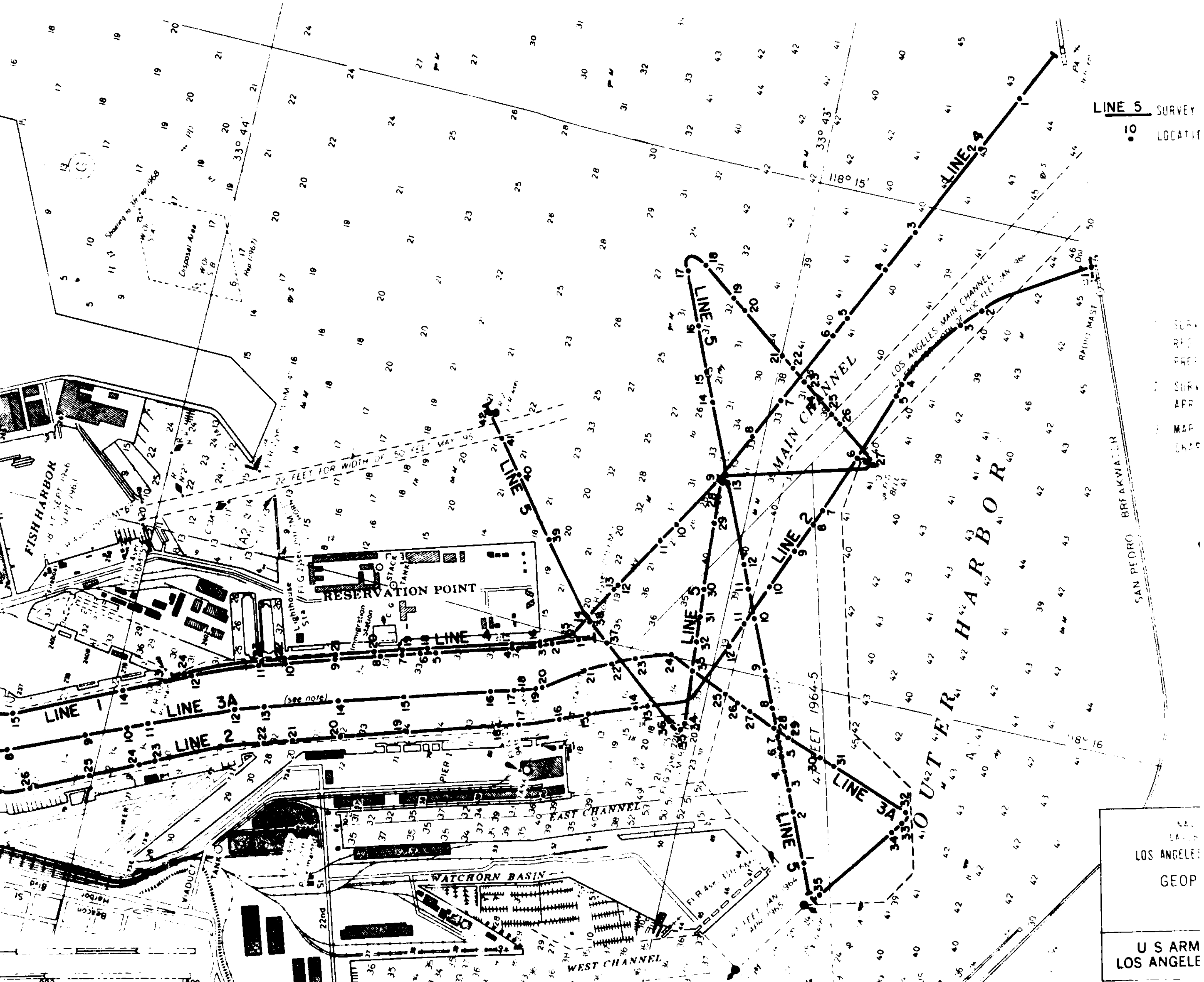
PLAN OF TEST HOLES

U S ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS

PLATE 1 SHEET 2

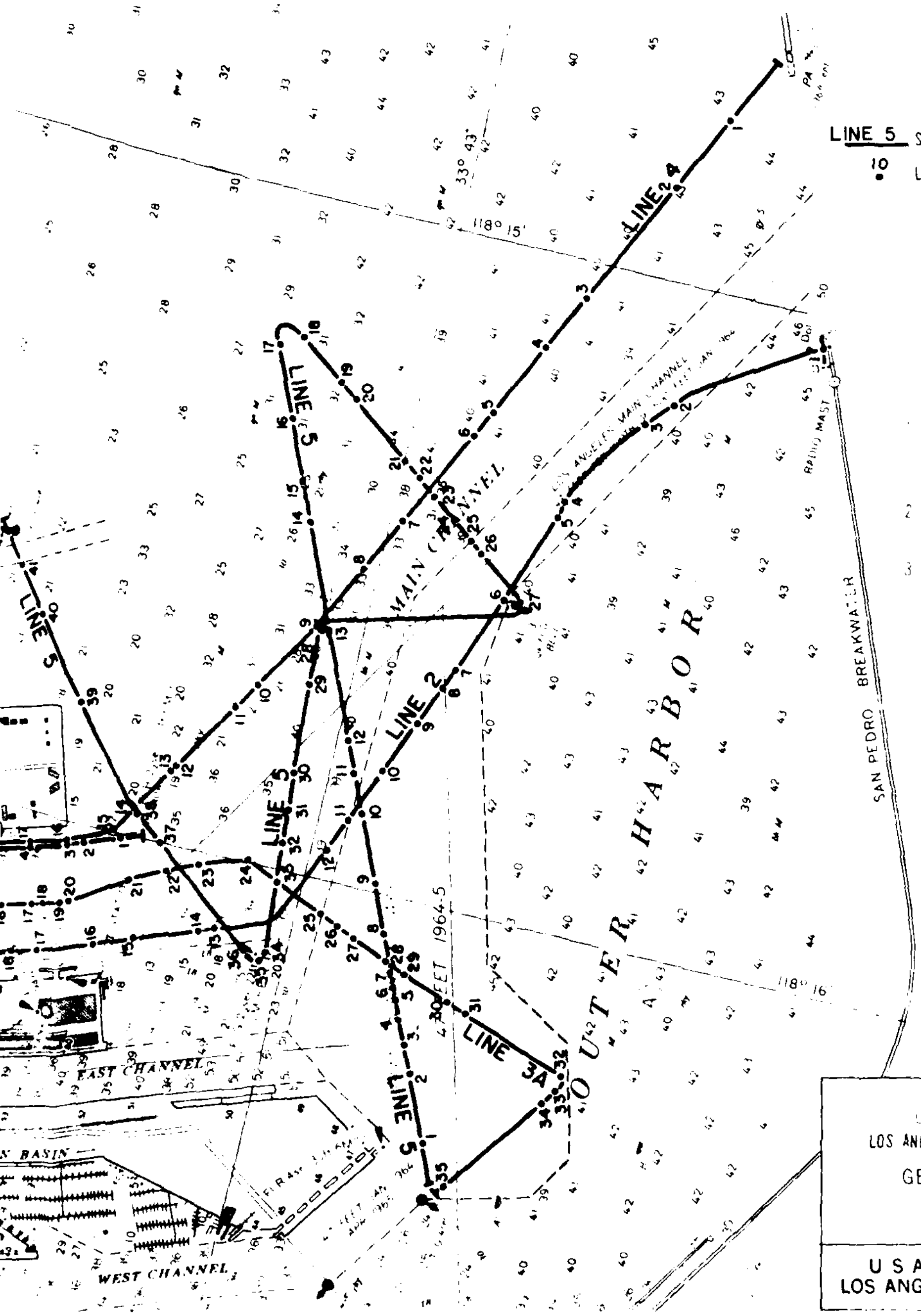


EAST BASIN CHANNEL
MORMON
TURNING BASIN
West Basin
East Basin
Northwest Slip
Southwest Slip
Slip No 5
Pacific Electric R.R.
EAST SAN PEDRO
LINE 3A
Ferry St
TOWER
TANK
STACKS
33° 46
33° 45



LINE 5 SURVEY
LOCATI
FISH HARBOR
RESERVATION POINT
Lighthouse Site
Immigration Station
MAIN CHANNEL
LOS ANGELES MAIN CHANNEL
OUTER HARBOR
LINE 1
LINE 2
LINE 3A
LINE 4
LINE 5
(see note)
PIER 1
EAST CHANNEL
WEST CHANNEL
WATCHORN BASIN
VIADUCT
Disposal Area
RADIO MAST
SAN PEDRO BREAKWATER
33° 44'
33° 43'
118° 15'
118° 16'
40 FEET 1964-5
LOS ANGELES
GEOP
U S ARM
LOS ANGELE

PLATE 2



LEGEND

LINE 5 SURVEY LINE BY DEAD RECKONING

10 LOCATION FIX POINT

NOTES

1. SURVEY CONSISTED OF A HIGH RESOLUTION BOOMER FOR THE PROFILING AND SIDE SCAN SONAR
2. SURVEY CONDUCTED ON 7 AND 8 APRIL 1977
3. MAP TAKEN FROM U S C & G S CHART 5142 MARCH 1974

NAVIGATION IMPROVEMENT
LA LB HARBORS CALIFORNIA
LOS ANGELES HARBOR CHANNEL DEEPENING

GEOPHYSICAL SURVEY

APRIL 1977

U S ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS

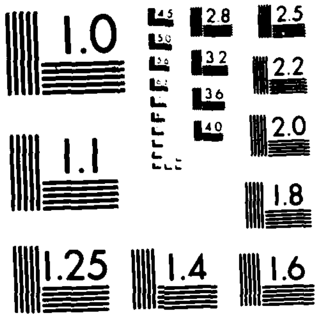
PLATE 2 SHEET 1

3

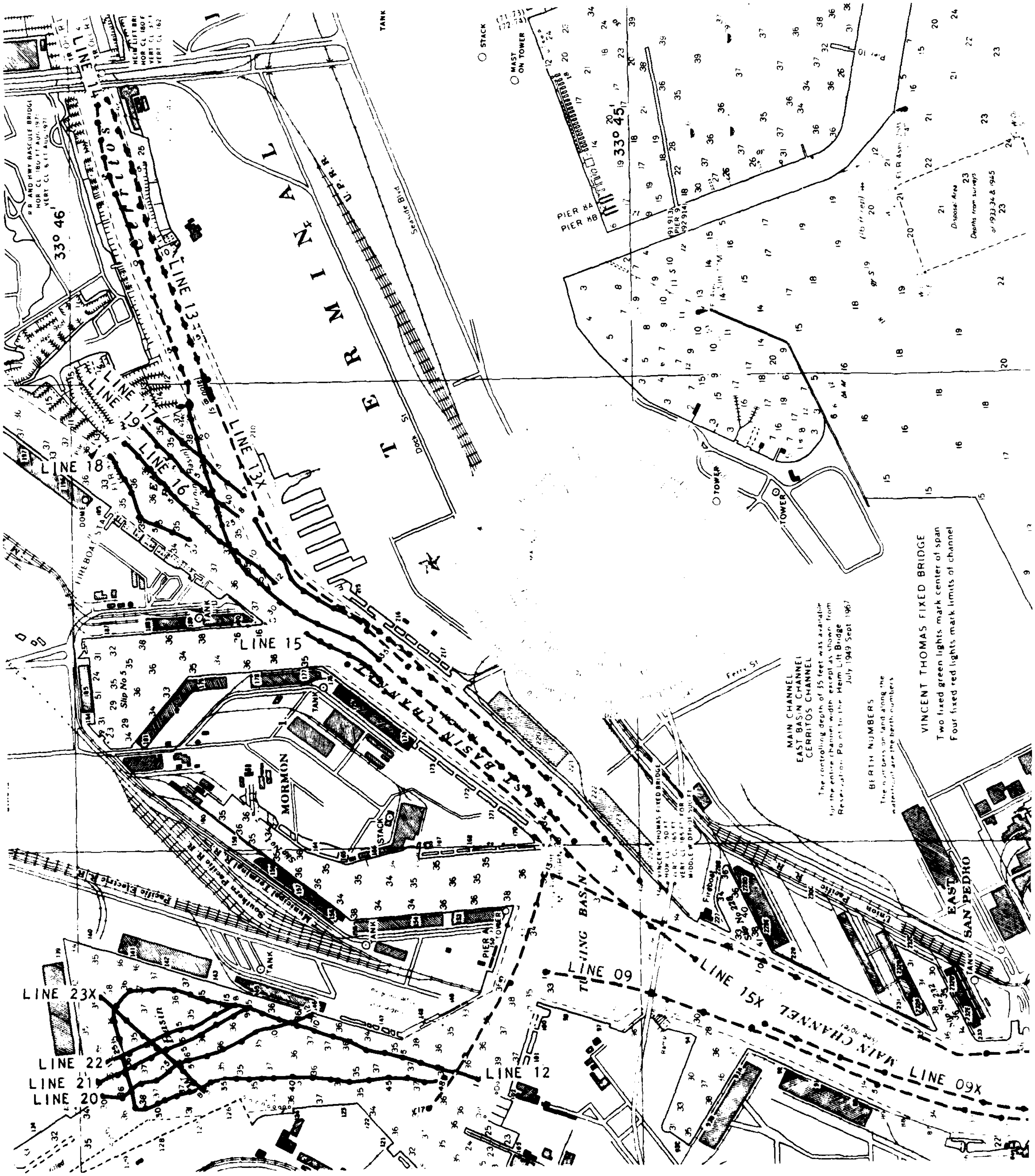
AD-A171 216   LOS ANGELES - LONG BEACH HARBORS CALIFORNIA LOS ANGELES HARBOR DEEPENING..(U) ARMY ENGINEER DISTRICT LOS ANGELES CA JAN 80   6/6

UNCLASSIFIED   F/G 13/2   NL

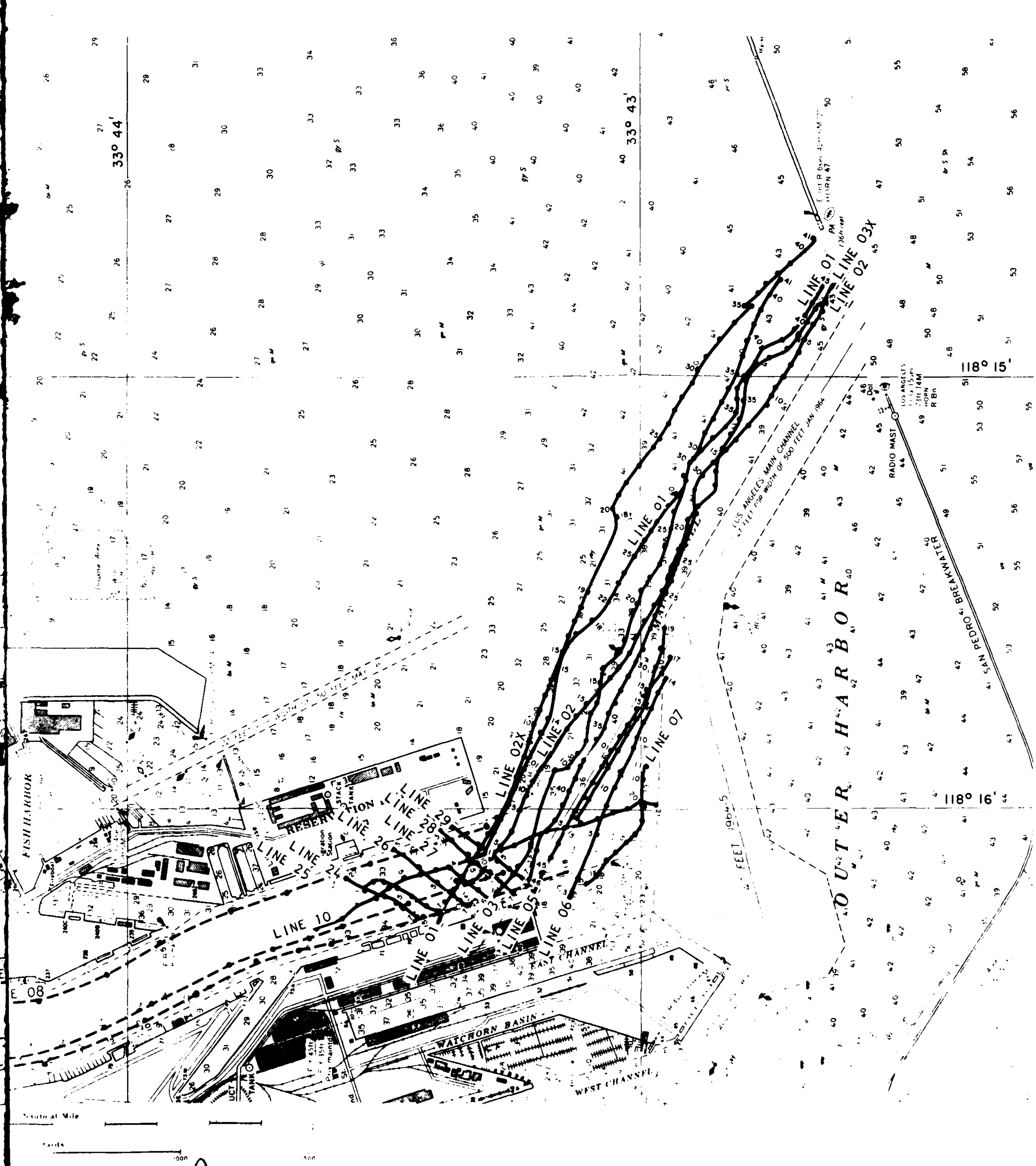
END
DATE
FILMED
9-86



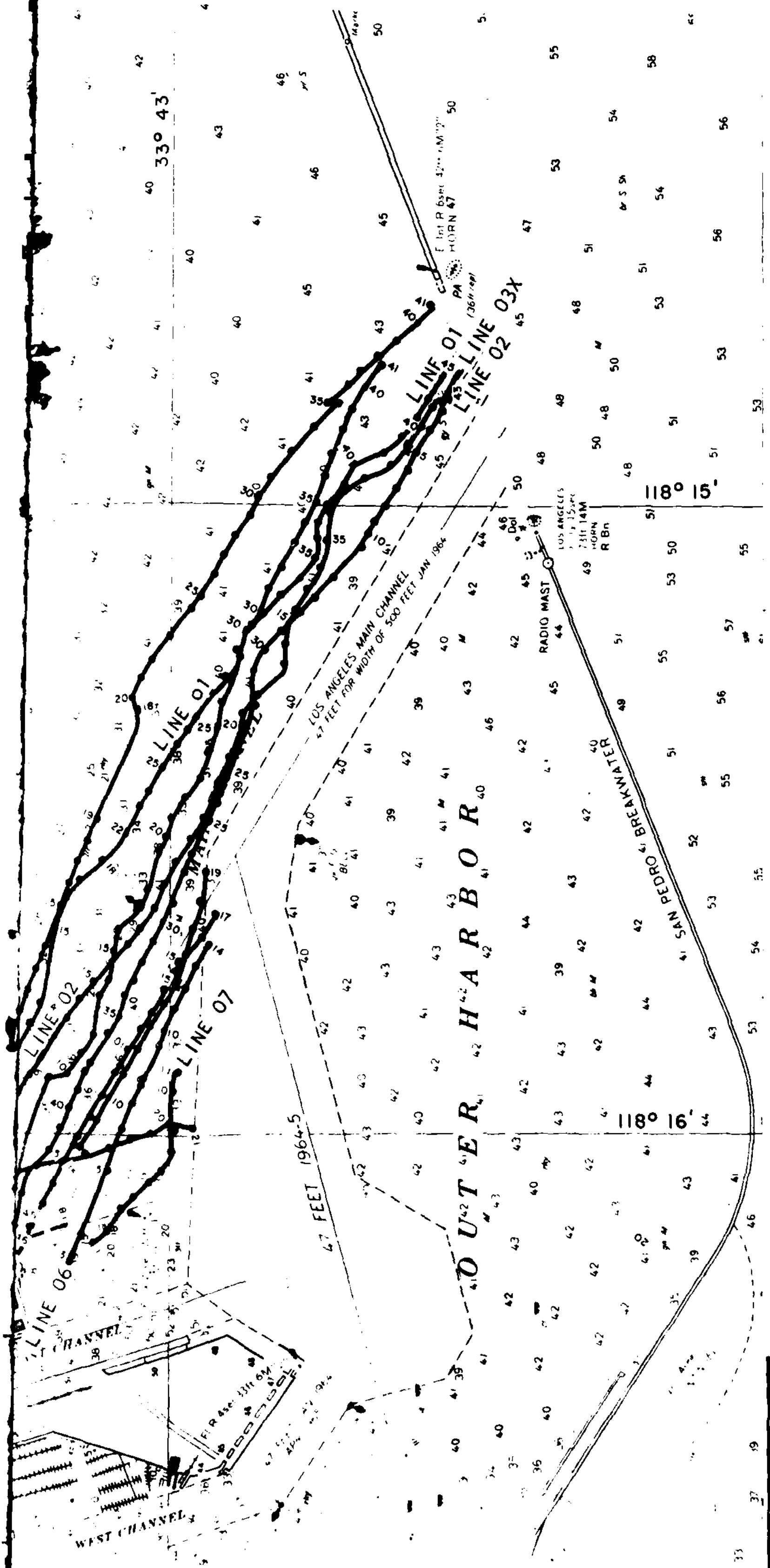
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A



LINE 13
LINE 13X
LINE 11
LINE 19
LINE 16
LINE 18
LINE 15
LINE 15X
LINE 09
LINE 09X
LINE 12
LINE 23X
LINE 22
LINE 21
LINE 20
TERMINAL
MORMON
MAIN CHANNEL
TURNING BASIN
EAST SAN PEDRO
PIER A
PIER 8A
PIER 8B
STACK
MAST ON TOWER
TOWER
TANK
DOME
VINCENT THOMAS FIXED BRIDGE
Two fixed green lights mark center of span
Four fixed red lights mark limits of channel
MAIN CHANNEL
EAST BASIN CHANNEL
CERRITOS CHANNEL
BERTH NUMBERS


33° 44'
33° 43'
118° 15'
118° 16'
LINE 01
LINE 02
LINE 03X
LINE 02X
LINE 03
LINE 05
LINE 06
LINE 07
LINE 10
LINE 24
LINE 25
LINE 26
LINE 27
LINE 28
LINE 29
OUTER HARBOR
SAN PEDRO BREAKWATER
LOS ANGELES MAIN CHANNEL
RADIO MAST
FISH HARBOR
WATCHORN BASIN
EAST CHANNEL
WEST CHANNEL
Nautical Mile
Yards

2



LEGEND

———	SURVEY LINE BY RADIO-NAVIGATION
– – – –	SURVEY LINE BY DEAD-RECKONING
•10	LOCATION "FIX" POINT
LINE 03	PINGER SURVEY
LINE 03X	BOOMER SURVEY

NOTES

1. SIDE SCAN SONAR CONDUCTED WITH PINGER SURVEY
2. SURVEY CONDUCTED ON 29 AND 30 NOVEMBER 1977.
3. MAP TAKEN FROM U.S.C. & G.S. CHART 5147, MARCH, 1974.

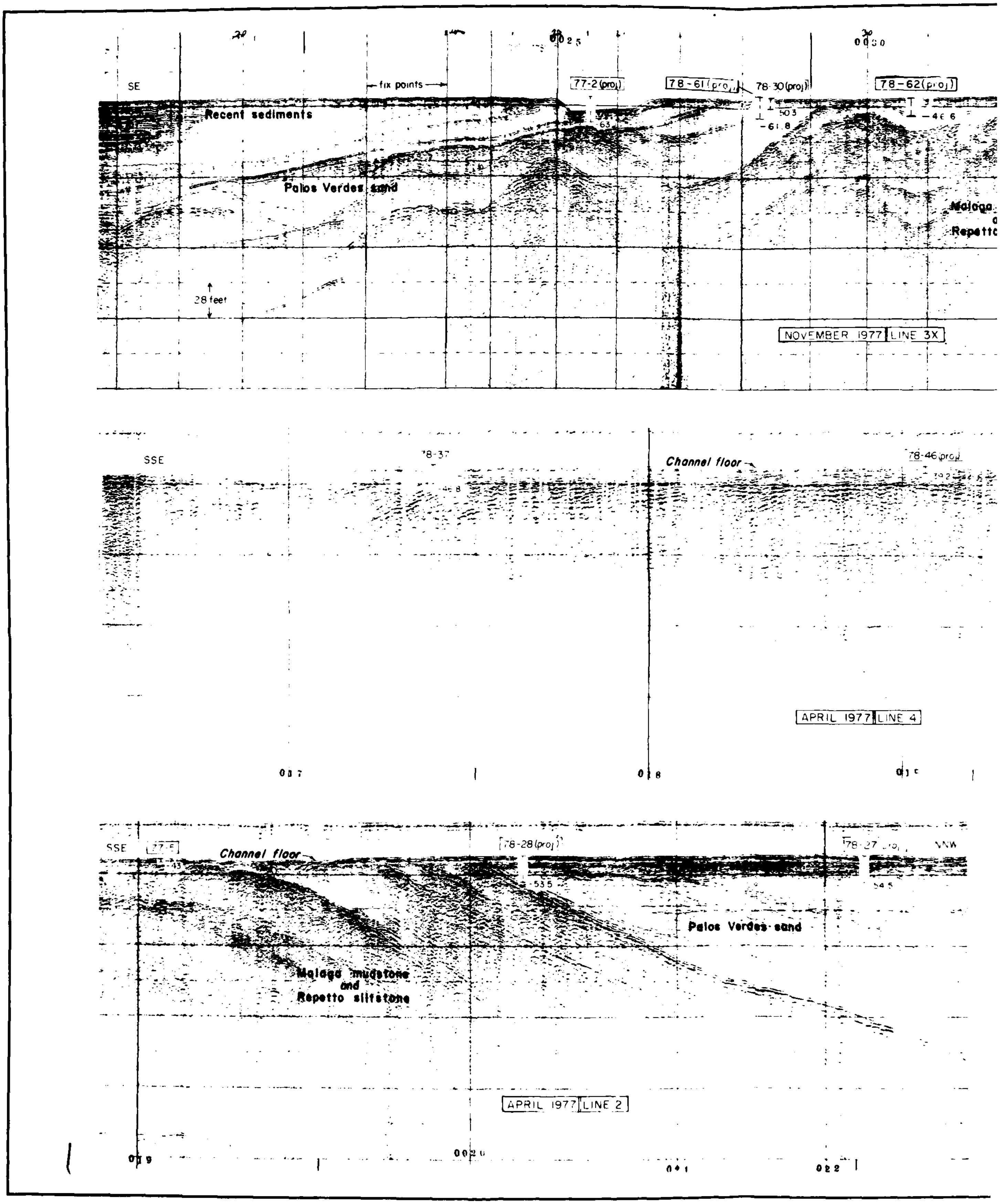
NAVIGATION IMPROVEMENT
LA-LB HARBORS, CALIFORNIA
LOS ANGELES HARBOR CHANNEL DEEPENING

GEOPHYSICAL SURVEY

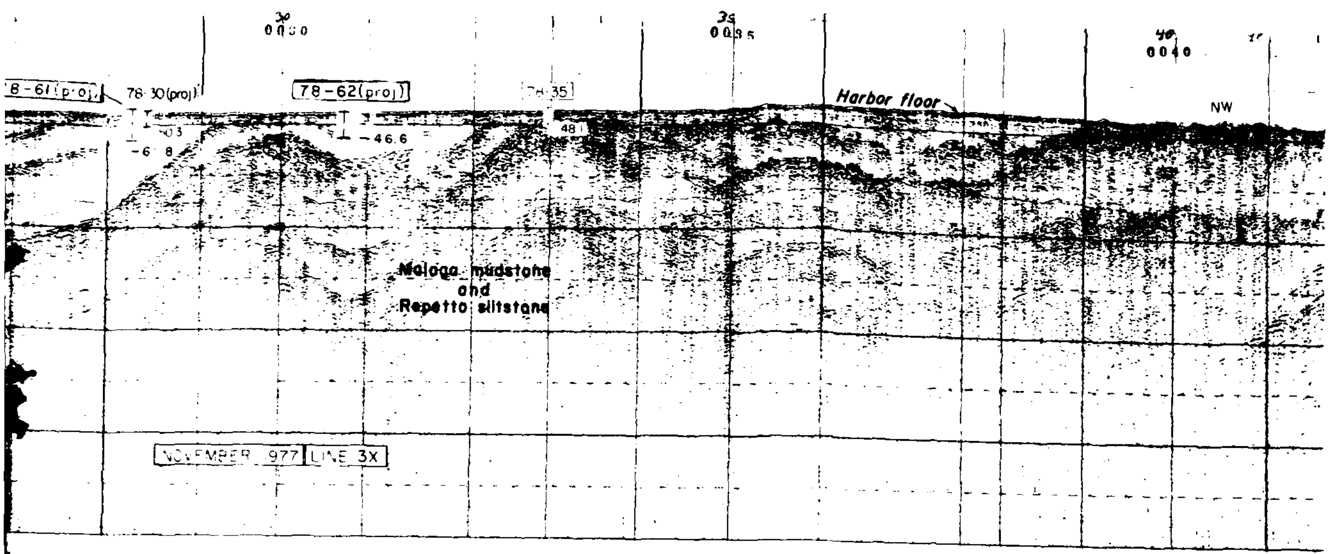
NOVEMBER 1977

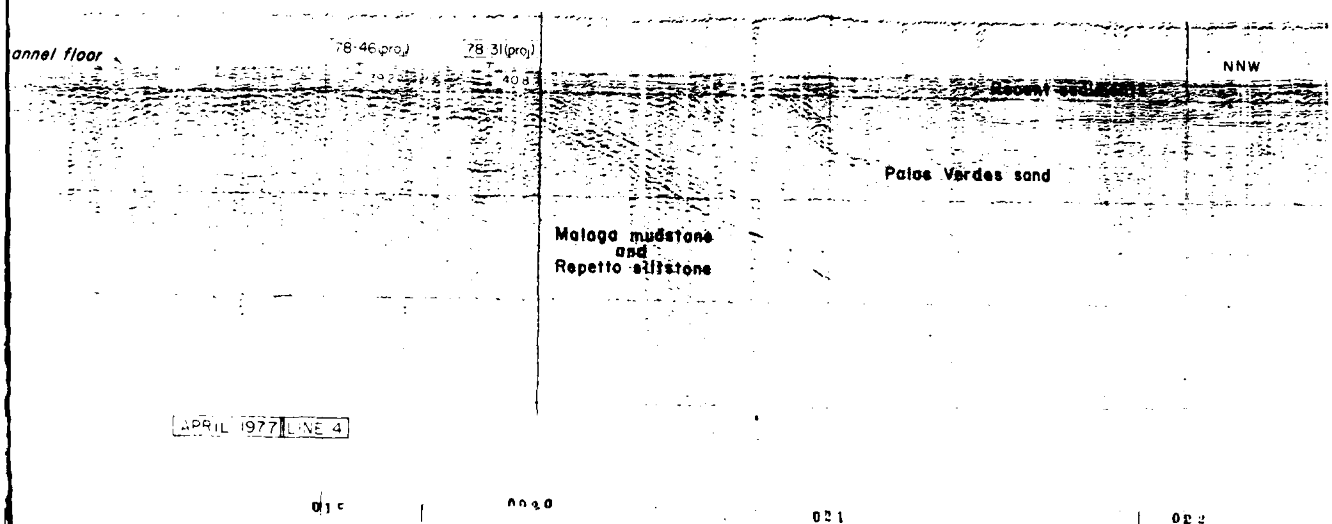
U S ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS

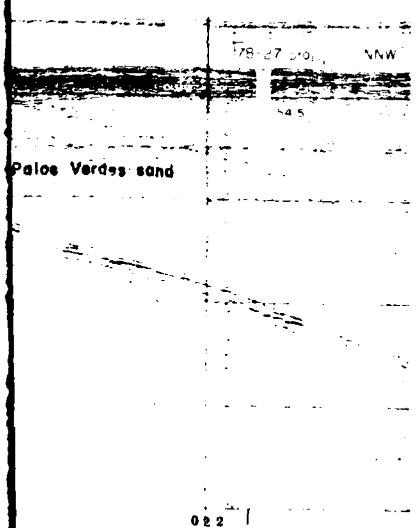
PLATE 2 3 SHEET 2



SE
fix points
77-2 (proj)
78-61 (proj)
78-30 (proj)
78-62 (proj)
Recent sediments
Palos Verdes sand
28 feet
NOVEMBER 1977 LINE 3X
SSE
Channel floor
78-46 (proj)
APRIL 1977 LINE 4
SSE
Channel floor
78-28 (proj)
Palos Verdes sand
Malaga mudstone and Repetto siltstone
APRIL 1977 LINE 2







LEGEND

SYMBOL	DESCRIPTIONS	DATE	APPROVAL

REVISIONS

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY

DRAWN BY

CHECKED BY

NAVIGATION IMPROVEMENT
L.A.-L.B. HARBORS, CALIFORNIA

LOS ANGELES HARBOR CHANNEL DEEPENING

GEOPHYSICAL "BOOMER" PROFILES

SUBMITTED BY:

APPROVAL RECOMMENDED

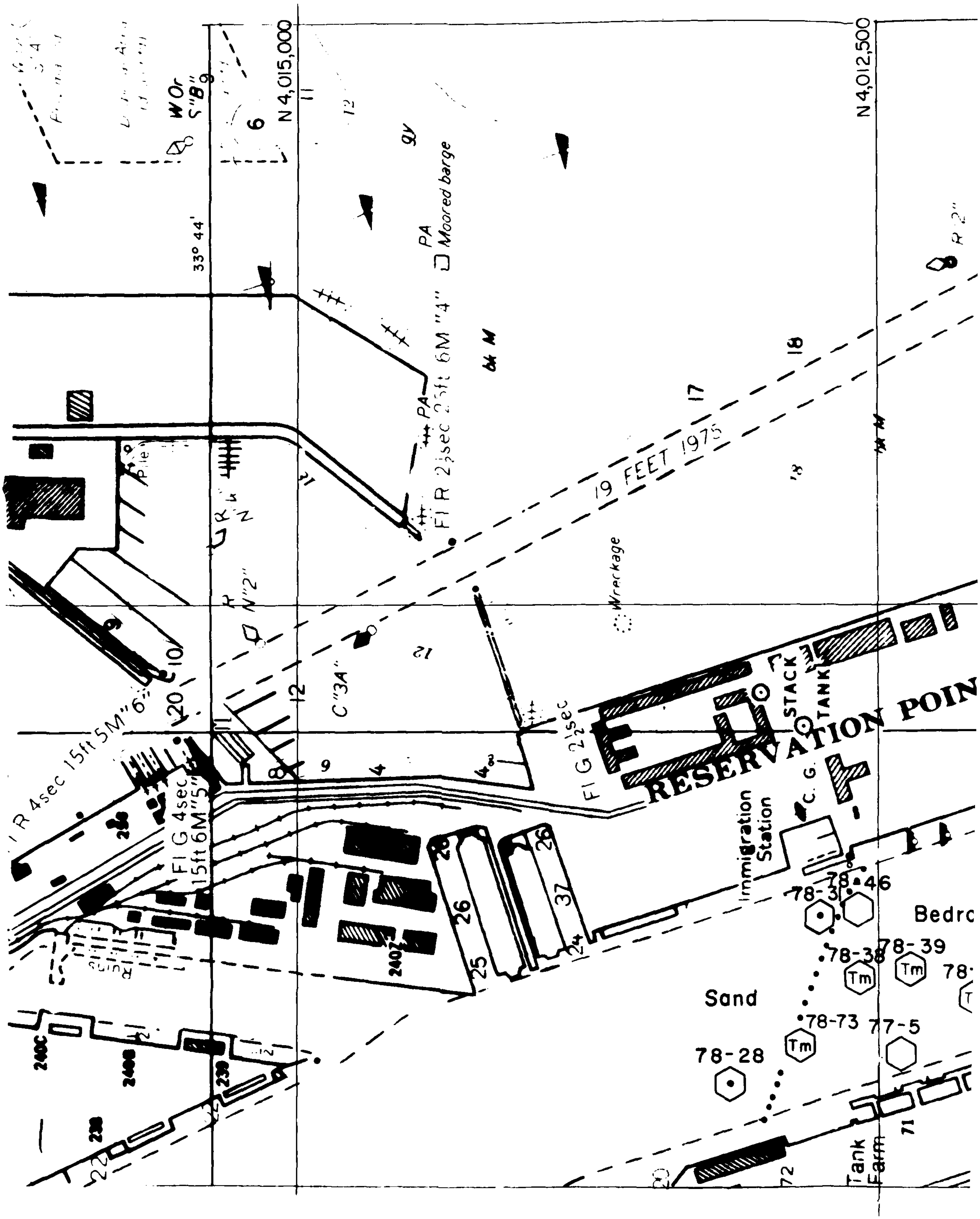
APPROVED

SPEC. NO. DACW09-
DISTRICT FILE NO.
DATE

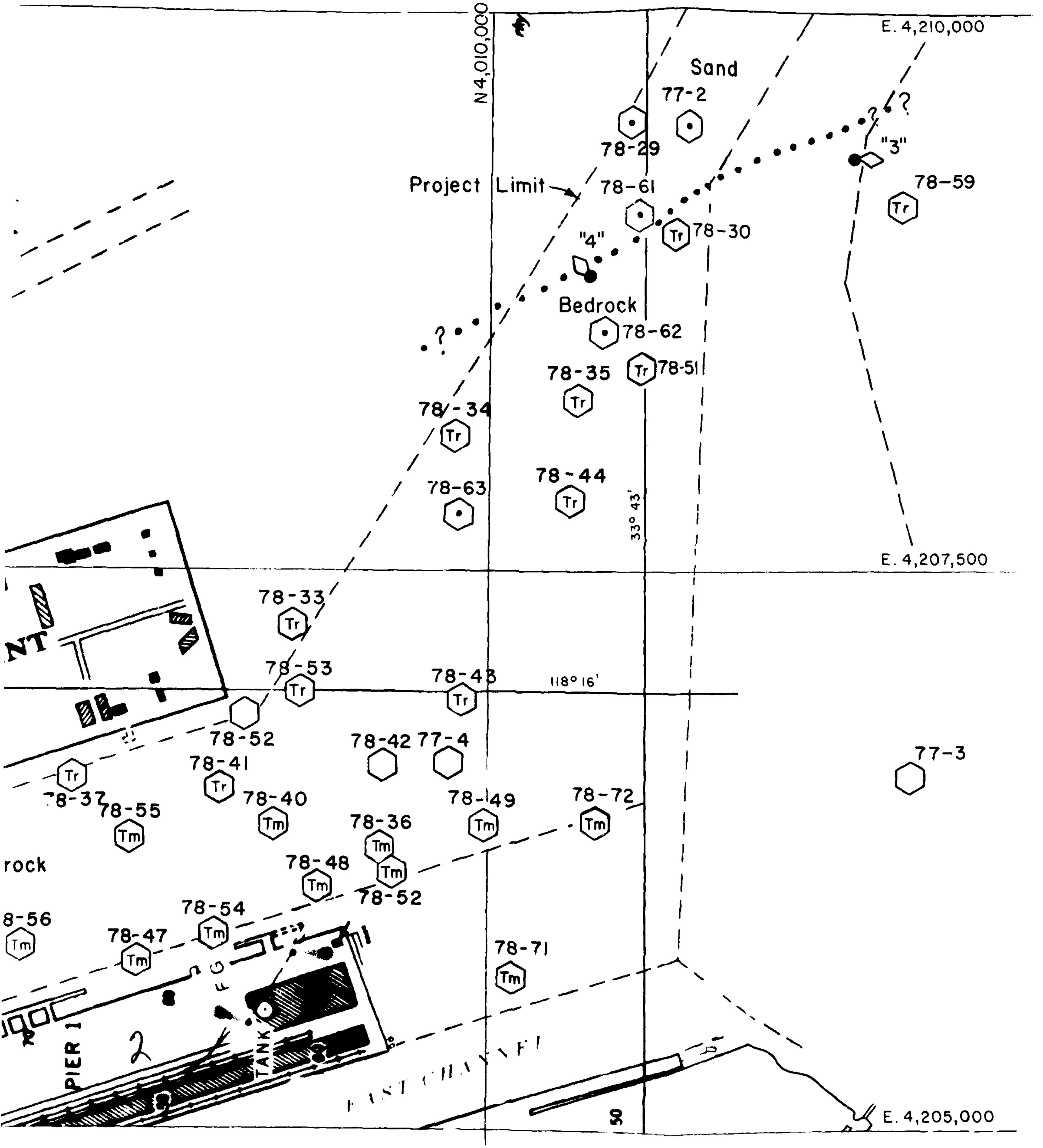
SHEET OF SHEETS

2

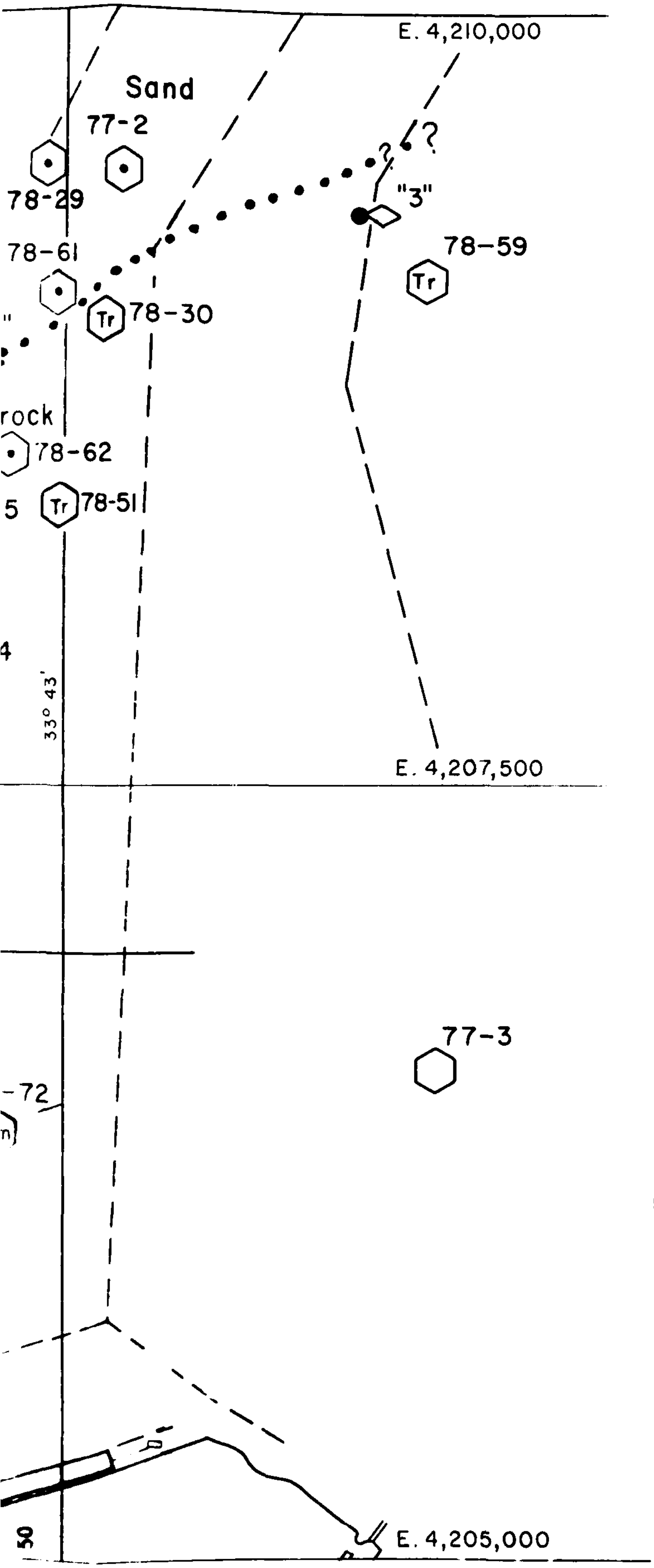
PLATE 3



N4,015,000
N4,012,500
33° 44'
W Or
S"B"
Moored barge
PA
Fl R 2½sec 25ft 6M "4"
19 FEET 1975
Wreckage
C"3A"
Fl R 4sec 15ft 5M "6"
Fl G 4sec 15ft 6M "5"
Fl G 2½sec
RESERVATION POINT
STACK
TANK
C. G.
Immigration Station
Bedro
Sand
78-46
78-3
78-38
78-39
78-73
77-5
78-28
Tm
Tank Farm
240C
240B
240Z



N4,010,000
E. 4,210,000
Sand
77-2
78-29
"3"
78-59
Project Limit
78-61
78-30
"4"
Bedrock
78-62
78-35
78-51
78-34
78-63
78-44
33° 43'
E. 4,207,500
NT
78-33
78-53
78-43
118° 16'
78-52
78-42
77-4
77-3
78-41
78-37
78-55
78-40
78-49
78-72
78-36
rock
78-48
78-52
8-56
78-54
78-47
78-71
FG
PIER 1
TANK
EAST CHANNEL
50
E. 4,205,000
Tr
Tm
?



LEGEND

• • • • • CONTACT BETWEEN FORMATIONS. QUERIED WHERE UNCERTAIN.

78-40 TEST HOLE INTO BEDROCK

78-29 TEST HOLE INTO UNCONSOLIDATED SEDIMENTS

Tr REPETTO SILTSTONE

Tm MALAGA MUDSTONE

NOTES

1. LOCATION OF SAND/BEDROCK CONTACT MAY VARY UP TO 100 FEET.
2. SEE PLATE 3 FOR LOGS OF TEST HOLES.
3. MAP TAKEN FROM U.S.C. & G.S. CHART 5147, MARCH 1974.

SCALE IN FEET

500 0 500 1000

NAVIGATION IMPROVEMENT
LA LB HARBORS, CALIFORNIA
LOS ANGELES HARBOR CHANNEL DEEPENING

3 LOS ANGELES HARBOR
SURFACE GEOLOGY

U S ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS

PLATE 4

TH 77-1

EL (FEET)	DEPTH	SOIL CLASS	10	40	60	100	200	LL	PI	OBG	Zn	Hg	Pb	Cd	DESCRIPTION
		MECHANICAL ANALYSIS (%)								BOTTOM SEDIMENT ANALYSIS (PPM)					
450	0.0														
470	2.0				100		29			179	90	.00	120	0.3	SANDY CLAY gray fat very loose clayey sand from 2' to 3'
480	3.0	CH		99		87	59	59	32	188	82	.00	170	0.3	
490	4.0														
510	6.0				100		87								
530	5.0	ML				99	90	45	17	258	87	.00	130	0.3	CLAY SILT gray trace of mica, loose to moderately stiff
570	12.0	CH-MH				99	9[illegible]	51	23	175	83	.00	190	0.3	
610	16.0	CH-MH				99	95	52	25	62	87	.00	100	0.3	
650	20.0	MH			100	98	96	54	23	44	101	.00	150	0.3	

TH 77-2

EL (FEET)	DEPTH	SOIL CLASS	10	40	60	100	200	LL	PI	OBG	Zn	Hg	Pb	Cd	DESCRIPTION
		MECHANICAL ANALYSIS (%)								BOTTOM SEDIMENT ANALYSIS (PPM)					
430	0.0														
440	[illegible]	SM	93	92	90		25			99	40	.00	40	[illegible]	SILTY SAND brown cohesive micaceous
445	2.5	SM	99	98	97		28	Δ	NP						
470	4.[illegible]				100		86			[illegible]9	40	.00	4[illegible]	0.3	SILT brown moderately soft
		SM				3[illegible]	33	Δ	NP						SILTY SAND brown cohesive micaceous
5[illegible]	7.[illegible]				100		[illegible]			49	49	.00	60	0.4	sandy
5[illegible]	8.0	ML				38	56	Δ	NP						SILT gray moderately soft
54[illegible]															
55[illegible]	2.0	MH				99	96	56	26	98	86	.00	2[illegible]	0.3	light gray
56[illegible]	3.0														
[illegible]9[illegible]	[illegible]	ML				99	36	47	9	56	89	.00	60	0.3	dark gray
6[illegible]	2[illegible]	CH				99	97	56	29	153	82	.00	30	0.3	

TH 77-3

EL (FEET)	DEPTH	SOIL CLASS	10	40	60	100	200	LL	PI	OBG	Zn	Hg	Pb	Cd	DESCRIPTION
		MECHANICAL ANALYSIS (%)								BOTTOM SEDIMENT ANALYSIS (PPM)					
[illegible]	[illegible]														
[illegible]	[illegible]	CH				99	98			482	59	.0[illegible]	6	1.2	CLAY dark gray fat
[illegible]	2.0														BEDROCK Formation not determined dark gray moderately hard

TH 77-4

EL (FEET)	DEPTH	SOIL CLASS	10	40	60	100	200	LL	PI	OBG	Zn	Hg	Pb	Cd	DESCRIPTION
		MECHANICAL ANALYSIS (%)								BOTTOM SEDIMENT ANALYSIS (PPM)					
360	0.0														
390	2.0	CH		98	97		86	6[illegible]	34	80	205	.03	660	0.9	CLAY dark gray, very soft odorous
400	4.0														
420	6.0	CH			99		97	76	45	240	43	.00	70	[illegible]	BEDROCK Repetto Siltstone (Tr) dark gray very stiff to hard friable slight odor
460	10.0	CH				98	96	96	55	27[illegible]	62	.00	[illegible]0	.6	

TH 77-5

EL (FEET)	DEPTH	SOIL CLASS	10	40	60	100	200	LL	PI	OBG	Zn	Hg	Pb	Cd	DESCRIPTION
		MECHANICAL ANALYSIS (%)								BOTTOM SEDIMENT ANALYSIS (PPM)					
41	0.0														
43	2.0	CH				100	97	116	65	345	[illegible]	.00	50	1.8	BEDROCK Repetto siltstone (Tr), dark gray very stiff to hard friable tendency to be fissile

TH 77-6

EL (FEET)	DEPTH	SOIL CLASS	10	40	60	100	200	LL	PI	OBG	Zn	Hg	Pb	Cd	DESCRIPTION
		MECHANICAL ANALYSIS (%)								BOTTOM SEDIMENT ANALYSIS (PPM)					
440	0.0														
450	1.0		90	82	66		35								
460	2.0	SM	84	44	32		18	Δ	NP	68	56	.00	70	[illegible]	SILTY SAND brown cohesive scattered pebbles to 1"
500	6.0	SP-SM	55	24	9		[illegible]	Δ	NP	39	[illegible]	[illegible]	30		
510	7.0														4" coarse gravelly sand layer
540	10.0	SP-SM	63	25	13		6	Δ	NP						more cohesive shale pebbles
570	13.0														
580	14.0	ML		99	98		82	30	7	67	130	.00	100	0.3	SILT brown

TH 78-1

EL (FEET)	DEPTH	SOIL CLASS	10	40	60	100	200	LL	PI	OBG	Zn	Hg	Pb	Cd	DESCRIPTION
		MECHANICAL ANALYSIS (%)								BOTTOM SEDIMENT ANALYSIS (PPM)					
-407	0.0														
-420	1.3	SM	[illegible]	[illegible]	[illegible]	84	4[illegible]	*	NP	[illegible]	[illegible]	[illegible]	4[illegible]	[illegible]	SILTY SAND gray moderate[illegible]
-437	3.0	ML	98	97	96	[illegible]	[illegible]	[illegible]	[illegible]	2[illegible]	[illegible]			6	SANDY SILT gray stiff [illegible] micaceous
-470	6.3														SILTY SAND gray [illegible] fine grained, micaceous
-491	8.4														
-497	9.0														CLAY gray, stiff, low plast[illegible]
-514	10.7														SILTY SAND gray, moderate[illegible]
-517	11.0														
-523	11.6	CH	98	97	[illegible]7	97	96	5[illegible]	[illegible]4						CLAY gray stiff some [illegible]
-539	13.2														SANDY CLAY gray medium [illegible] fine sand
-563	15.6														SILT AND SAND [illegible] gray [illegible] consistency layered
-606	19.9														

TH 78-2

EL (FEET)	DEPTH	SOIL CLASS	10	40	60	100	200	LL	PI	OBG	Zn	Hg	Pb	Cd	DESCRIPTION
		MECHANICAL ANALYSIS (%)								BOTTOM SEDIMENT ANALYSIS (PPM)					
-353	0.0									2970	20[illegible]	[illegible]	991	[illegible]	MUCK CLAY gray to b[illegible]
-383	3.0	[illegible]				99	86	57	35	2350	[illegible]	[illegible]	662	1.5	
-403	5.0														
-413	[illegible]														SANDY CLAY gray soft
-423	7.[illegible]	[illegible]				97	72	40	6	590	39	2.3	57	0.6	CLAY black, moderate[illegible]
		SM		98	94	64	6	*	NP	300	[illegible]	[illegible]	122	0.5	SILTY SAND, gray [illegible] shell fragments thru[illegible]
-463	[illegible]														
		[illegible]				99	98	74	40	2[illegible]	[illegible]	[illegible]	84	0.9	CLAY gray moderate[illegible]
-493	4[illegible]														SILTY SAND same as [illegible]
-5[illegible]3	[illegible]														CLAY AND SAND gray [illegible] & density, layered
-529	[illegible]														

TH 78-3

EL (FEET)	DEPTH	SOIL CLASS	10	40	60	100	200	LL	PI	OBG	Zn	Hg	Pb	Cd	DESCRIPTION
		MECHANICAL ANALYSIS (%)								BOTTOM SEDIMENT ANALYSIS (PPM)					
-36	[illegible]														
		[illegible]	[illegible]	99	97	92	70	57	3[illegible]	[illegible]0	80	2.4	44[illegible]	[illegible]	MUCK CLAY gray [illegible] moderate[illegible] shell layers
-4[illegible]	4[illegible]														
-42[illegible]	6[illegible]	ML				99	88	Δ	NP	[illegible]0	8[illegible]	[illegible]	54	[illegible]	SILT gray, medium [illegible]
										250	73	[illegible]	4[illegible]6	[illegible]	
-45	[illegible]	ML					99	Δ	NP						
										200	182	[illegible]	[illegible]4	0.7	
-48	[illegible]														
-48[illegible]	[illegible]														
		ML		99	98	98	92	Δ	NP						
-553	19.2														

TH 78-4

EL (FEET)	DEPTH	SOIL CLASS	10	40	60	100	200	LL	PI	OBG	Zn	Hg	Pb	Cd	DESCRIPTION
		MECHANICAL ANALYSIS (%)								BOTTOM SEDIMENT ANALYSIS (PPM)					
-359	0.0														
		[illegible]H	[illegible]	98	97	95	84	70	39	2990	[illegible]97	[illegible]	339	[illegible]8	MUCK CLAY dark gray [illegible] sandy [illegible]
-389	3.0														
		ML		99	97	88	6[illegible]	*	NP	[illegible]	168	0.4	[illegible]5	[illegible]	CLAY SANDY SILT AN[illegible] moderately st[illegible]
-415	5.6														
		SP-SM	[illegible]	47	39	27	10	*	NP	[illegible]	124	0.3	[illegible]	[illegible]4	SAND SILTY SAND gray [illegible] abundant shell fragme[illegible]
-440	8[illegible]														
		ML	[illegible]	96	95	94	90	*	NP	7[illegible]	154	0.2	6	[illegible]5	SILT gray, medium [illegible] un-layered
-470	[illegible]														
-564	20.5														

TH 78-1

SEDIMENT ANALYSIS PPM	DESCRIPTION
[illegible]	SILTY SAND gray, moderately loose
[illegible]	SANDY SILT gray, stiff, odorless
[illegible]	SILTY SAND gray, moderately dense, fine grained, micaceous
[illegible]	CLAY gray, stiff, low plasticity
[illegible]	SILTY SAND gray, moderately dense
[illegible]	CLAY gray, stiff, some organics
[illegible]	SANDY CLAY gray, medium consistency, fine sand
[illegible]	SILT AND SANDY SILT gray, medium consistency, layered

TH 78-2

SEDIMENT ANALYSIS PPM	DESCRIPTION
[illegible]	MUCK CLAY gray to black, soft, odorous
[illegible]	SANDY CLAY gray, soft
[illegible]	CLAY black, moderately stiff
[illegible]	SILTY SAND gray, moderately dense, shell fragments throughout
[illegible]	CLAY gray, moderately stiff
[illegible]	SILTY SAND same as [illegible]
[illegible]	CLAY AND SAND gray, medium consistency and density, layered

TH 78-3

SEDIMENT ANALYSIS PPM	DESCRIPTION
[illegible]	MUCK CLAY gray black, moderately stiff [illegible] shell layers
[illegible]	SILT gray, medium consistency, odorless [illegible]

TH 78-4

SEDIMENT ANALYSIS PPM	DESCRIPTION
[illegible]	MUCK CLAY dark gray, soft, odorous, sandy 5 to 6.6'
[illegible]	CLAY, SANDY SILT AND SILTY SAND moderately stiff, layered
[illegible]	SAND, SILTY SAND gray, medium density, abundant shell fragments
[illegible]	SILT gray, medium to stiff consistency, unlayered

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COARSE GRAINED SOILS More than half of material is larger than no. 200 sieve size	GRAVELS More than half of coarse fraction is larger than no. 4 sieve size	Clean gravels	GW	Well graded gravels, gravel-sand mixtures, little or no fines
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines
		Gravels with fines	GM	Silty gravels, gravel-sand-silt mixtures
			GC	Clayey gravels, gravel-sand-clay mixtures
	SANDS More than half of coarse fraction is smaller than no. 4 sieve size	Clean sands	SW	Well graded sands, gravelly sands, little or no fines
			SP	Poorly graded sands, gravelly sands, little or no fines
		Sands with fines	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures
FINE GRAINED SOILS More than half of material is smaller than no. 200 sieve size	SILTS AND CLAYS	Low liquid limit	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts, with slight plasticity
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
			OL	Organic silts and organic silty clays of low plasticity
		High liquid limit	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
			CH	Inorganic clays of high plasticity, fat clays
			OH	Organic clays of medium to high plasticity, organic silts
Highly organic soils			Pt	Peat and other highly organic soils

NOTES

[illegible]

POLLUTANT	MAXIMUM PPM
Oil and grease (O & G)	2,800
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

[illegible]

LEGEND

10	PERCENT OF MATERIAL BY WEIGHT PASSING NO. 10 SIEVE
40	PERCENT OF MATERIAL BY WEIGHT PASSING NO. 40 SIEVE
60	PERCENT OF MATERIAL BY WEIGHT PASSING NO. 60 SIEVE
100	PERCENT OF MATERIAL BY WEIGHT PASSING NO. 100 SIEVE
200	PERCENT OF MATERIAL BY WEIGHT PASSING NO. 200 SIEVE
*	VISUAL LABORATORY DETERMINATION
Δ	TESTED LABORATORY DETERMINATION
LL	LIQUID LIMIT
PI	PLASTICITY INDEX (LIQUID LIMIT MINUS PLASTIC LIMIT)
NP	NON PLASTIC

SYMBOL	DESCRIPTIONS	DATE	APPROVAL

REVISIONS

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY:
DRAWN BY:
CHECKED BY:

NAVIGATION IMPROVEMENT
LA-LB HARBORS, CALIFORNIA

LOS ANGELES HARBOR CHANNEL DEEPENING

LOGS OF TEST HOLES

SUBMITTED BY:
APPROVED:
APPROVAL RECOMMENDED
SPEC NO. DACW09-
DISTRICT FILE NO.
DATE
SHEET 6 OF 6 SHEETS

PLATE 5

TH 78-5

EL.	DEPTH (FEET)	SOIL CLASS	MECHANICAL ANALYSIS (%) -4 40 60 100 200 LL PI	BOTTOM SEDIMENT ANALYSIS (PPM) O&G Zn Hg Pb Cd	DESCRIPTION
41.2	0.0				
42.8	1.6	SM	99 98 92 46 * NP	33 [illegible] 49 3.5	SILTY SAND gray, moderately dense
44.7	3.5	ML	99 96 75 [illegible] NP	240 [illegible] 76 0.5	SILT gray, moderately stiff
		SM	96 92 90 76 28 * NP	260 128 1.2 64 0.6	SILTY SAND gray, dense, many shell fragments, abundant [illegible] to 7.0'
48.2	7.0				SILT gray, soft
49.0	7.8				CLAYEY SAND gray, stiff, many shell fragments
50.7	9.5				SAND-SILTY SAND gray, very dense, fine grained
54.7	13.5				

TH 78-6

EL.	DEPTH (FEET)	SOIL CLASS	MECHANICAL ANALYSIS (%) -4 40 60 100 200 LL PI	BOTTOM SEDIMENT ANALYSIS (PPM) O&G Zn Hg Pb Cd	DESCRIPTION
43.3	0.0				
44.5	1.2	MH	87 82 81 79 72 77 20	[illegible] 196 0.4 240 [illegible]	SILT gray, soft to medium consistency, many shells, very little odor
		ML	99 98 98 96 78 * NP	300 178 0.3 52 [illegible]	SANDY SILT gray, moderately dense to dense, unlayered
48.8	5.5				
		[illegible]	99 57 29		[illegible] gray, medium to stiff [illegible]
53.7	10.4				
55.5	12.2				SILTY SAND, SANDY SILT gray

TH 78-7

EL.	DEPTH (FEET)	SOIL CLASS	MECHANICAL ANALYSIS (%) -4 40 60 100 200 LL PI	BOTTOM SEDIMENT ANALYSIS (PPM) O&G Zn Hg Pb Cd	DESCRIPTION
35.5	0.0				
		ML	99 97 89 [illegible] NP	4470 [illegible] 2.6 06 [illegible]	MUCK SILT dark gray, soft, odorous
38.7	3.2				
40.3	4.8	CL	99 98 97 95 69 37 13	770 433 [illegible] 175 [illegible]	CLAY dark gray, soft to medium consistency, sandy
		ML	99 9 * NP	310 68 [illegible] 4	SILT [illegible] medium gray, moderately stiff, [illegible]
43.4	7.9				
		ML	99 98 92 * NP	550 28 [illegible] 78 [illegible]	
47.0	11.5				
50.6	15.1				
		CL	99 97 94 36 14		CLAY gray, moderately stiff
53.1	17.6				SILTY SAND gray, moderately dense to 19.4' then dense, fine grained
55.5	20.0				

TH 78-8

EL.	DEPTH (FEET)	SOIL CLASS	MECHANICAL ANALYSIS (%) -4 40 60 100 200 LL PI	BOTTOM SEDIMENT ANALYSIS (PPM) O&G Zn Hg Pb Cd	DESCRIPTION
35.0	0.0				
36.3	1.3	M	99 98 94 84	2690 195 [illegible] 2 744 1.3	MUCK SILT dark gray, soft, slight odor
		MH	99 97 87 64 3	236 [illegible] 740 [illegible]	SILT dark gray, moderately stiff, [illegible] shell fragments
39.2	4.2				
		SM	99 74 13 * NP	400 165 0.1 82 0.6	SAND-SILTY SAND gray to brown, moderately dense, unlayered
44.0	9.0				
		SP-SM	99 98 73 10 * NP	10 159 0.4 57 0.7	
47.0	12.0				
52.9	17.9				

TH 78-9

EL.	DEPTH (FEET)	SOIL CLASS	MECHANICAL ANALYSIS (%) -4 40 60 100 200 LL PI	BOTTOM SEDIMENT ANALYSIS (PPM) O&G Zn Hg Pb Cd	DESCRIPTION
37.6	0.0				
		SM	82 74 72 48 28 [illegible] NP	220 356 0.2 140 1.4	SILTY SAND gray, moderately dense, abundant shells and shell fragments below 2.6', stiff clay layer 2.1' to 2.6'
41.2	3.6				
		ML	99 40 14	80 165 0.3 52 0.5	SILT light gray, moderately stiff, a few thin layers of shell fragments, otherwise homogeneous
44.6	7.0				
		ML	99 97 35 6	270 181 0.1 111 0.7	
47.6	10.0				
56.2	18.6				
57.3	19.7				SANDY CLAY gray, stiff

TH 78-10

EL.	DEPTH (FEET)	SOIL CLASS	MECHANICAL ANALYSIS (%) -4 40 60 100 200 LL PI	BOTTOM SEDIMENT ANALYSIS (PPM) O&G Zn Hg Pb Cd	DESCRIPTION
37.9	0.0				[illegible]
		SM	[illegible] 24 * NP	[illegible]	[illegible]
40.9	3.0				
		SM	[illegible] 4 * NP	240 [illegible]	
43.9	6.0				
		SM	[illegible] 24 * NP	[illegible]	
46.9	9.0				
51.8	13.9				SAND yellow brown, medium grained, medium dense
53.2	15.3				SAND-CLAY AND SANDY CLAY gray, [illegible] medium consistency [illegible]
56.7	18.8				

TH 78-11

EL.	DEPTH (FEET)	SOIL CLASS	MECHANICAL ANALYSIS (%) -4 40 60 100 200 LL PI	BOTTOM SEDIMENT ANALYSIS (PPM) O&G Zn Hg Pb Cd	DESCRIPTION
35.5	0.0				MUCK SANDY CLAY dark gray, [illegible] moderate odor
		CL	99 94 78 47 25	[illegible] 26 0.8 [illegible]	
38.8	3.3				
39.6	4.1				SANDY CLAY gray, yellow and [illegible], very stiff to hard
		CL	98 96 95 86 56 3 2	260 97 0.7 [illegible]	
41.8	6.3				SILTY SAND gray, [illegible], dense, [illegible] thin clay seams
		SM	99 97 96 85 44 * NP	260 78 [illegible] 68 [illegible]	
45.2	9.7				
		ML	98 97 38 2	430 40 [illegible] 92 [illegible]	SILT AND SANDY SILT tan and [illegible], medium to stiff, very stiff [illegible]
47.0	11.5				
51.2	15.7				SILTY SAND gray [illegible]
51.9	16.4	SM	[illegible] 49 65 [illegible] * NP		

TH 78-12

EL.	DEPTH (FEET)	SOIL CLASS	MECHANICAL ANALYSIS (%) -4 40 60 100 200 LL PI	BOTTOM SEDIMENT ANALYSIS (PPM) O&G Zn Hg Pb Cd	DESCRIPTION
36.2	0.0				MUCK CLAYEY SAND dark gray, moderately [illegible] layered [illegible]
		SC	97 [illegible] 76 43 35 3	440 339 [illegible]	
38.9	2.7				CLAY [illegible] gray, moderately [illegible]
		CH	99 98 96 97 65 36	430 [illegible] 0.4 86 [illegible]	
41.7	5.5				SAND-SILTY SAND gray, dense, [illegible] moderately dense [illegible]
		SM	[illegible] 37 6 * NP	[illegible] 81 [illegible] 79 [illegible]	
45.2	9.0				
		SP-SM	[illegible] 29 [illegible] * NP	[illegible] 5 [illegible] 23	
48.2	12.0				
48.9	12.7				SAND gray, moderately dense, [illegible] shell fragments [illegible]
52.2	16.0				SAND, SILTY SAND AND CLAY
53.3	[illegible]				SAND, SILTY SAND gray, [illegible] moderately dense
55.4	[illegible]				

TH 78-13

EL.	DEPTH (FEET)	SOIL CLASS	MECHANICAL ANALYSIS (%) -4 40 60 100 200 LL PI	BOTTOM SEDIMENT ANALYSIS (PPM) O&G Zn Hg Pb Cd	DESCRIPTION
37.0	0.0				SAND gray, [illegible]
		SP	[illegible] 28 4 * NP	[illegible]	
40.0	3.0				
		SP	[illegible] * NP	480 [illegible] 79 [illegible] 24	
43.0	6.0				
		SP	[illegible] 22 [illegible] * NP	44 [illegible]	
47.0	10.0				
50.7	9.7				

TH 78-14

EL.	DEPTH (FEET)	SOIL CLASS	MECHANICAL ANALYSIS (%) -4 40 60 100 200 LL PI	BOTTOM SEDIMENT ANALYSIS (PPM) O&G Zn Hg Pb Cd	DESCRIPTION
36.6	0.0				CLAY gray to greenish gray, [illegible] moderately stiff below [illegible] fragments throughout [illegible] 0 to 6
		CH	[illegible] 98 [illegible] 96 93 51 30	430 189 0.8 123 0.8	
39.6	3.0				
		CH	98 98 97 97 64 35	280 75 0 [illegible] 3 0.2	
42.6	6.0				
		CH	98 98 97 97 76 45	170 74 0.3 72 0.8	
45.3	8.7				
46.2	9.6	PT	98 93 [illegible] 62 48 * NP	4860 38 0.5 21 0.2	PEAT brown black, medium [illegible]
		CL	97 [illegible] 79 60 21 5	60 78 0.3 82 0.7	SANDY CLAY greenish gray, moderately stiff, some organic matter, gradational contact with PT [illegible]
48.2	11.6				
52.2	15.6				

TH 78-15

DESCRIPTION

TH 78-16

	MECHANICAL ANALYSIS %	BOTTOM SEDIMENT ANALYSIS (PPM)	DESCRIPTION
	[illegible]	B Zn Hg Pb Cd	SILTY SAND gray and gray brown, soft ed ... 12.9 ... moderately dense ... grained ... 8 to ... very dense below 15.5 ... shell fragments ... generally uniform

TH 78-17

	MECHANICAL ANALYSIS %	BOTTOM SEDIMENT ANALYSIS (PPM)	DESCRIPTION
	... 45 25	9... 2 ... 0.8 25 ... 0.9	MUCK SANDY CLAY dark gray, soft to moderately stiff, odorous
	... 27	48 ... 3.5 ... 4 10.5 0.5	CLAY greenish gray, moderately stiff, occasional shell fragments ... 8.3 to 9.5 ... fine to very fine sand below 14.9
	... 27	400 ... 64 ... 08 ... 9.0 ...	

TH 78-18

ELEV	DEPTH FEET	MECHANICAL ANALYSIS %	BOTTOM SEDIMENT ANALYSIS (PPM)	DESCRIPTION
35.7	0.0	CLASS ... P	B Zn Hg Pb Cd	
	2.0	SM ... 56 4... NP	... 15 ... 6 26.5 ... 6	SILTY SAND dark gray ... moderately loose ...
	3.3			SAND yellow brown ... mostly ... pebbles
	4.0	CL ... 35 86 ... 76 50 12	50 203 0.3 82 0.7	SILT & CLAY light brown ... stiff ... shell fragments below 6
43.4	...	ML ... 95 35 45 18	... 99 0.6 ... 0.8	
44.3	8.6	ML ... 88 ... 82 35 9		

TH 78-14

	BOTTOM SEDIMENT ANALYSIS (PPM)	DESCRIPTION
	[illegible]	CLAY gray to greenish gray, soft to 1.6, moderately stiff below, many shell fragments throughout, slight odor 0 to 1.6
	[illegible]	PEAT brown black, medium density
	... 8 ...	SANDY CLAY greenish gray, moderately stiff, some organic material, gradational contact with Pt ...

NOTES

1. See ...
2. See ...

SYMBOL	DESCRIPTIONS	DATE	APPROVAL

REVISIONS

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY

DRAWN BY

CHECKED BY

NAVIGATION IMPROVEMENT
L.A.-L.B. HARBORS, CALIFORNIA

LOS ANGELES HARBOR CHANNEL DEEPENING

LOGS OF TEST HOLES

SUBMITTED BY:

APPROVED

APPROVAL RECOMMENDED

SPEC NO. DACW 09

DISTRICT FILE NO

DATE

SHEET ... OF 6 SHEETS

PLATE 5

2

TH 78-19

EL	DEPTH (FEET)	MECHANICAL ANALYSIS (%)								BOTTOM SEDIMENT ANALYSIS (PPM)					DESCRIPTION
		SOIL CLASS	-10	-40	-60	-100	-200	LL	PI	O&G	Zn	Hg	Pb	Cd	
367	00														
387	20	SC	99	94	74	52	41	26	12	350	369	01	211	07	CLAYEY SAND dark gray, medium density, some shell fragments
4[illegible]7	50	CL		98	90	74	55	23	8	1370	127	13	68	[illegible]0	SANDY CLAY gray-brown to brown, stiff to hard

TH 78-20

EL	DEPTH (FEET)	MECHANICAL ANALYSIS (%)								BOTTOM SEDIMENT ANALYSIS (PPM)					DESCRIPTION
		SOIL CLASS	-10	-40	-60	-100	-200	LL	PI	O&G	Zn	Hg	Pb	Cd	
397	00														SANDY CLAY dark gray to 8 7 gray-brown to 11 8' moderately stiff to 8 7 stiff to very stiff to 11 8' coarser sand below 10 8' occasional shell fragments abundant above 2 2
42	30	CH	96	95	94	91	88	51	27	210	133	01	67	06	
45	60	CL		99	98	94	84	42	22	320	183	11	99	05	
478	87	CL	99	99	92	8[illegible]	67	34	17	370	220	01	53	04	
509	[illegible]8														

TH 78-21

EL	DEPTH (FEET)	MECHANICAL ANALYSIS (%)								BOTTOM SEDIMENT ANALYSIS (PPM)					DESCRIPTION
		SOIL CLASS	-10	-40	-60	-100	-200	LL	PI	O&G	Zn	Hg	Pb	Cd	
350	00														
362	12														MUCK SILT dark gray, soft
380	30	SM		97	84	50	26	*	NP	910	156	03	296	09	SILTY SAND dark gray, moderately loose to medium dense, slight oil odor
405	5[illegible]														
410	60	SM		95	73	40	22	*	NP	860	176	07	368	08	
440	90	SP	98	72	48	22	4	*	NP	80	73	0[illegible]		503	SAND, SILTY SAND gray brown to brown, medium dense to 11 9', dense to 15 7'
470	120	SP SM		8[illegible]	[illegible]4	3[illegible]	2	*	NP	510	89	02	33	03	
507	157														

TH 78-22

EL	DEPTH (FEET)	MECHANICAL ANALYSIS (%)								BOTTOM SEDIMENT ANALYSIS (PPM)					DESCRIPTION
		SOIL CLASS	-10	-40	-60	-100	-200	LL	PI	O&G	Zn	Hg	Pb	Cd	
395	00														
405	10														MUCK SILT dark gray, soft, odorless
426	31	SM		99	95	55	22	*	NP	790	249	01	363	04	SILTY SAND dark gray, medium density, some shells
470	75	SP			98	44	3	*	NP	300	523	02	637	14	SAND light brown, medium density, unlayered
480	85														SILTY SAND gray and gold brown, dense to very dense, thinly layered, mostly fine grained
585	195														

TH 78-23

EL	DEPTH (FEET)	MECHANICAL ANALYSIS (%)								BOTTOM SEDIMENT ANALYSIS (PPM)					DESCRIPTION
		SOIL CLASS	-10	-40	-60	-100	-200	LL	PI	O&G	Zn	Hg	Pb	Cd	
360	00														
391	31	ML	99	96	91	80	64	-	-	1700	200	05	377	10	MUCK SANDY SILT dark gray, very soft to soft, occasional pebbles of sand stone, oil odor
434	74	CL	99	96	92	85	80	28	8	380	176	01	124	06	SANDY CLAY brown to gray, soft to 4 8' then stiff
470	110	SM		95	81	68	48	Δ	NP	130	148	03	72	10	SILTY SAND brown, medium density, several thin layers of shell fragments but generally unlayered
519	159														
530	170														SAND light brown, medium density, fine to coarse grained, mostly medium

TH 78-24

EL	DEPTH (FEET)	MECHANICAL ANALYSIS (%)								BOTTOM SEDIMENT ANALYSIS (PPM)					DESCRIPTION
		SOIL CLASS	-10	-40	-60	-100	-200	LL	PI	O&G	Zn	Hg	Pb	Cd	
388	00														
418	30	[illegible]			9[illegible]	[illegible]	8[illegible]	4	9	190	170	[illegible]	[illegible]	[illegible]	CLAY light gray, modera[illegible] [illegible] sand [illegible] abundant shell fragments
448	60	M[illegible]				99	94	40	4	50	185	[illegible]	[illegible]	6	some shell fragments be[illegible]
477	89	[illegible]				99	91	42	[illegible]	500	275	[illegible]	62	[illegible]	
583	195														

TH 78-25

EL	DEPTH (FEET)	MECHANICAL ANALYSIS (%)								BOTTOM SEDIMENT ANALYSIS (PPM)					DESCRIPTION
		SOIL CLASS	-10	-40	-60	-100	-200	LL	PI	O&G	Zn	Hg	Pb	Cd	
399	00														MUCK SANDY SILT dark gray, petroleum odor [illegible]
429	30	ML	99	[illegible]	90	8[illegible]	69	*	NP	2830	73	10	22	[illegible]	
450	5[illegible]														
458	59	CL	96	9[illegible]	90	82	74	32	10	14[illegible]	[illegible]8	[illegible]5	46[illegible]	[illegible]	CLAY light gray [illegible]
488	89	CL		98	97	96	90	43	23	410	182	09	95	[illegible]2	CLAY gray, moderately [illegible] unlayered, some [illegible]
511	112														
524	125														CLAYEY SAND gray, fine-medium grained [illegible]

TH 78-26

EL	DEPTH (FEET)	MECHANICAL ANALYSIS (%)								BOTTOM SEDIMENT ANALYSIS (PPM)					DESCRIPTION
		SOIL CLASS	-10	-40	-60	-100	-200	LL	PI	O&G	Zn	Hg	Pb	Cd	
320	00														MUCK CLAY dark gray, [illegible] shell and [illegible] fragments, odor
369	48	CH		99	97	93	87	53	26	1330	153	18	414	09	
406	86	SP		96	5[illegible]	4	4	Δ	NP	260	119	03	15	[illegible]3	SAND gray [illegible] medium dense to [illegible]
440	120	SM		98	92	[illegible]	37	Δ	NP	170	167	07	71	04	SILTY SAND brown [illegible]
447	127														
470	150	SP SM		94	66	[illegible]	[illegible]	Δ	NP	140	143	04	43	06	SAND gray to 14 [illegible] rust and gray [illegible]
519	199														SAND AND CLAYEY SAND [illegible] moist, not layered [illegible] grained

TH 78-27

EL	DEPTH (FEET)	MECHANICAL ANALYSIS (%)								BOTTOM SEDIMENT ANALYSIS (PPM)					DESCRIPTION
		SOIL CLASS	-10	-40	-60	-100	-200	LL	PI	O&G	Zn	Hg	Pb	Cd	
383	00														
397	14														SANDY SILT dark gray
411	28	SM	95	6[illegible]	[illegible]	20	16	*	NP	700	144	07	200	0[illegible]	SAND, SILTY SAND gray, abundant shell fragments
441	58	SP	82	3[illegible]	[illegible]	7	4	*	NP	190	61	06	78	[illegible]	SAND gray to [illegible] medium dense to [illegible]
471	88	SP	89	55	[illegible]	5	4	*	NP	410	69	01	57	05	where dense [illegible] shell fragments below
545	162														

TH 78-28

EL	DEPTH (FEET)	MECHANICAL ANALYSIS (%)								BOTTOM SEDIMENT ANALYSIS (PPM)					DESCRIPTION
		SOIL CLASS	-10	-40	-60	-100	-200	LL	PI	O&G	Zn	Hg	Pb	Cd	
370	00														
378	08														MUCK SILT dark gray
400	30	SW SM	98	6[illegible]	[illegible]	5	[illegible]	*	NP	2870	150	06	217	10	SAND brown and gray [illegible] dense where shells [illegible] shell fragments thro[illegible]
425	55	SP	89	6[illegible]	[illegible]	8	4	*	NP	430	64	01	94	10	
430	60														SAND [illegible] SILTY SAND AND [illegible] dense, shells to [illegible]
442	72	SP SM	72	32	[illegible]	15	7	*	NP	210	65	06	74	10	SAND brown, medium [illegible] grained below 8 9
470	100														
479	109														SAND, SILTY SAND AND [illegible]
496	126														CLAY gray, stiff [illegible]
527	157														SAND, SILTY SAND, gray [illegible] medium grained, some [illegible]
535	165														

TH 78-24

MECHANICAL ANALYSIS (%)	BOTTOM SEDIMENT ANALYSIS (PPM) O&G Zn Hg Pb Cd	DESCRIPTION
[illegible]	[illegible]	CLAY light gray, moderately stiff to 8.4', sandier and more dense to 9.6', abundant shell fragments ... some shell fragments below

TH 78-25

MECHANICAL ANALYSIS (%)	BOTTOM SEDIMENT ANALYSIS (PPM) O&G Zn Hg Pb Cd	DESCRIPTION
[illegible]	[illegible]	MUCK SANDY SILT dark gray, soft, petroleum odor, occasional shells
[illegible]	5 460	CLAY light gray, moderately stiff
[illegible]	82 09 95 2 2	CLAY gray, moderately stiff, unlayered, some organics and shells
		CLAYEY SAND gray brown, dense, fine to medium grained, unlayered

TH 78-26

MECHANICAL ANALYSIS (%)	BOTTOM SEDIMENT ANALYSIS (PPM) O&G Zn Hg Pb Cd	DESCRIPTION
[illegible]	6 414 9	MUCK CLAY dark gray, soft, occasional shells and wood fragments, slight odor
[illegible] NP	[illegible]	SAND gray, gold and brown, mottled, medium density, thin silt seams to 5'
[illegible] NP	[illegible] 4	SILTY SAND brown, medium density
[illegible] NP	4 4 5 0 6	SAND gray to 14', then gold, brown, rust and gray, thinly layered
		SAND AND CLAYEY SAND brown, dense, indistinct layering, mostly fine grained

TH 78-27

MECHANICAL ANALYSIS (%)	BOTTOM SEDIMENT ANALYSIS (PPM) O&G Zn Hg Pb Cd	DESCRIPTION
[illegible] NP	44 0 7 [illegible]	SANDY SILT dark gray, soft
		SAND-SILTY SAND gray, medium dense, abundant shell fragments
[illegible]	6 36 78	SAND gray to 8', light brown to 16.2', medium density except 4.2' to 5.7' where dense, finer grained and no shell fragments below 8'
[illegible] NP	5 7 0 5	

TH 78-28

MECHANICAL ANALYSIS (%)	BOTTOM SEDIMENT ANALYSIS (PPM) O&G Zn Hg Pb Cd	DESCRIPTION
		MUCK SILT dark gray, soft
[illegible] * NP	2870 53 06 217 1 0	SAND brown and gray, medium density, dense where shells more abundant, many shell fragments throughout
[illegible] 63 4 * NP	430 64 01 94 1 0	SAND, SILTY SAND AND SHELLS light gray, dense, shells to 1/2"
[illegible] 72 2 7 * NP	20 65 06 74 1 0	SAND brown, medium density, coarser grained below 9.9', very few shells
		SAND, SILTY SAND AND SHELLS
		CLAY gray, stiff, homogeneous
		SAND, SILTY SAND gray brown, medium density, medium grained, some fine

TH 78-29

EL.	DEPTH (FEET)	SOIL CLASS	10	40	60	100	200	LL	PI	DESCRIPTION
33.1	0.0									SAND gray, light brown, mottled gray brown, medium density to 5.5', dense to 8.5', thin silt layer at 1.0', abundant shell fragments below 4.5'
36.0	2.9	SP-SM		99	79	4	[illegible]	*	NP	
38.6	5.5	SP		45	48	6	2	*	NP	
41.6	8.5	SP-SM	97	87	42	[illegible]	5	*	NP	

TH 78-30

EL.	DEPTH (FEET)	SOIL CLASS	10	40	60	100	200	LL	PI	O&G	Zn	Hg	Pb	Cd	DESCRIPTION
41.3	0.0														
43.2	1.9	ML		99	98	95	75	39	13	680	268	0.4	126	0.7	SANDY SILT dark brown, very soft, micaceous
															BEDROCK Repetto siltstone, dark brown, very stiff to hard, friable, massive, some foraminifera, slight odor
48.3	7.0														
48.8	7.5	CH			89	78	68	78	46						
50.3	9.0														

TH 78-31

EL.	DEPTH (FEET)	SOIL CLASS	10	40	60	100	200	LL	PI	O&G	Zn	Hg	Pb	Cd	DESCRIPTION
34.0	0.0														MUCK SANDY CLAY dark gray, soft, odorless
		CH		92	83	77	70	68	43	1110	122	0.6	48	0.8	
38.4	4.4														SILTY SAND gray and brown, medium density, thin layers ..., shells and shell fragments
40.8	6.8	SM	98	64	31	20	16	Δ	NP	160	212	0.2	279	1.2	

TH 78-32

EL.	DEPTH (FEET)	SOIL CLASS	10	40	60	100	200	LL	PI	O&G	Zn	Hg	Pb	Cd	DESCRIPTION
40.0	0.0														MUCK SILT dark gray, soft, several thin clay layers, some shell fragments above
43.2	3.2	ML	97	93	87	77	69	38	6	660	203	0.5	239	1.3	
															CLAY light gray and gray, moderately stiff, unlayered
47.0	7.0	CH		99	98	97	94	59	33	750	163	[illegible]	87	0.5	
51.7	11.7														SAND, SILTY SAND gray, medium density, mostly medium grained
52.5	12.5														SAND light brown, medium density, fine to coarse grained
53.8	13.8														

NOTES

1. See plate [illegible] for location of test holes.
2. See sheet 1 for [illegible]
3. No [illegible] Test Hole 78-29

SYMBOL	DESCRIPTIONS	DATE	APPROVAL

REVISIONS

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY:

DRAWN BY:

CHECKED BY:

NAVIGATION IMPROVEMENT
L.A.-L.B. HARBORS, CALIFORNIA

LOS ANGELES HARBOR CHANNEL DEEPENING

LOGS OF TEST HOLES

SUBMITTED BY:

APPROVED

APPROVAL RECOMMENDED

SPEC. NO. DACW 09- [illegible]
DISTRICT FILE NO.
DATE

SHEET 6

PLATE 5

2

TH 78-33

EL	DEPTH (FEET)		DESCRIPTION
240	00		
-250	10	NO TESTING	SILT dark gray, loose, very fine to fine grained
			BEDROCK-Repetto siltstone (Tr) dark brown, very stiff to hard, foraminiferal
307	67		

TH 78-34

EL	DEPTH (FEET)		DESCRIPTION
-261	00		
-269	08	NO TESTING	SILTY SAND gray, loose, fine to coarse grained, many shell fragments
			BEDROCK-Repetto siltstone (Tr) dark brown, very stiff to hard, friable, many foraminifera
331	70		

TH 78-44

EL	DEPTH (FEET)		DESCRIPTION
-425	00		
		NO TESTING	BEDROCK Repetto siltstone (Tr)? dark gray, very stiff to hard, friable, massive, abundant foraminifera, slight odor
-494	69		

TH 78-35

EL	DEPTH (FEET)	SOIL CLASS	-10	-40	-60	-100	-200	LL	PI	O&G	Zn	Hg	Pb	Cd	DESCRIPTION
		MECHANICAL ANALYSIS (%)								BOTTOM SEDIMENT ANALYSIS (PPM)					
-399	00														
		ML	99	98	94	81	66	48	19	610	18 2	1 0	19 8	0 8	SANDY SILT gray, soft, odorless
-434	35														
															BEDROCK-Repetto siltstone (Tr) dark brown, foraminiferal, very stiff, slight odor
-481	82														

TH 78-45

EL	DEPTH (FEET)	SOIL CLASS	-10	-40	-60	-100	-200	LL	PI	DESCRIPTION
		MECHANICAL ANALYSIS (%)								
-404	00									
		SP	92	5[illegible]	3[illegible]	14	6	*	NP	SAND gray, moderate density, shell fragments above 1 9
-435	31									
		SP	99	91	55	10	5	*	NP	
-465	61									
		SM		99	9[illegible]	6[illegible]	4[illegible]	*	NP	SILTY SAND, SILT & CLAY gray, alternating layers 1" to [illegible] thick, moderate density and stiffness
-518	114									
		ML				99	93	54	23	SANDY SILT gray, moderate stiffness
569	165									

TH 78-36

EL	DEPTH (FEET)	SOIL CLASS	-10	-40	-60	-100	-200	LL	PI	O&G	Zn	Hg	Pb	Cd	DESCRIPTION
		MECHANICAL ANALYSIS (%)								BOTTOM SEDIMENT ANALYSIS (PPM)					
-340	00														
		MH			98	87	72	72	30	570	14 0	0 8	17 7	1 2	SANDY SILT gray, soft to moderately stiff, some shell fragments, odorless
-384	44														
															BEDROCK-Malaga mudstone (Tm)? dark brown, stiff to hard, some foraminifera, tendency to be fissile
-465	125														

TH 78-46

EL	DEPTH (FEET)	CLASS	-10	-40	-60	-100	200	LL	PI	DESCRIPTION
		MECHANICAL ANALYSIS (%)								
-328	00									
		CH			99	96	90	64	35	MUCK CLAY gray to gray brown, soft to 2 5', moderately stiff below, slight odor
-380	52									BEDROCK (?) Broken angular rocks in clay matrix
-392	64									

TH 78-37

EL	DEPTH (FEET)	SOIL CLASS	-10	-40	-60	-100	-200	LL	PI	O&G	Zn	Hg	Pb	Cd	DESCRIPTION
		MECHANICAL ANALYSIS (%)								BOTTOM SEDIMENT ANALYSIS (PPM)					
323	00														
		CH				98	96	73	42	780	21 5	0 5	26 6	1 3	CLAY gray to 7', brownish gray to 9 6', soft to moderately stiff, unlayered, slight odor
-353	30														
		CH		99	97	94	90	67	35	740	19 9	0 4	20 4	1 1	
383	60														
		CH				99	97	82	53	520	19 2	0 9	18 9	1 1	
419	96														
															BEDROCK-Repetto siltstone (Tr)? dark brown, very stiff to hard, friable, sandy
468	145														

TH 78-47

EL	DEPTH (FEET)	CLASS	-10	-40	-60	-100	-200	LL	PI	DESCRIPTION
		MECHANICAL ANALYSIS (%)								
-296	00									
		CH		99	98	92	85	65	33	MUCK SILT dark gray, moderately stiff, few shell fragments and angular pebbles to 2", some pieces of soft bedrock below 4 2', odorless
-326	30									
		ML			99	95	90	58	27	
-361	65									
										BEDROCK Malaga mudstone (Tm) dark gray, stiff to moderately hard, friable, massive, foraminiferal, slight odor
449	153									

TH 78-48

EL	DEPTH (FEET)		DESCRIPTION
335	00		
		NO TESTING	MUCK SILT dark gray, soft to 2 8', moderately stiff below, sandy, some pieces of bedrock, slight odor
389	54		
			BEDROCK-Malaga mudstone (Tm) gray to brown, very stiff to moderately hard, friable, crude bedding dipping 10° to 15°, foraminiferal, slight odor
-465	130		

TH 78-38

EL	DEPTH (FEET)		DESCRIPTION
-385	00		
		NO TESTING	BEDROCK-Malaga mudstone (Tm) dark brown, very stiff to hard, friable, slight odor
-447	62		

TH 78-39

EL	DEPTH (FEET)		DESCRIPTION
-388	00		
		NO TESTING	BEDROCK Malaga mudstone (Tm) dark brown, very stiff to hard, friable, sandy, some foraminifera, slight tendency to be fissile
-449	61		

TH 78-49

EL	DEPTH (FEET)	SOIL CLASS	-10	-40	-60	-100	200	LL	PI	DESCRIPTION
		MECHANICAL ANALYSIS (%)								
-309	00									
		MH			99	95	85	63	23	MUCK SILT gray, moderately stiff, layered, slight odor
-361	56									
-367	58									BEDROCK (?)

TH 78-40

EL	DEPTH (FEET)		DESCRIPTION
406	00		
		NO TESTING	BEDROCK-Malaga mudstone (Tm)?; dark gray, stiff to slightly hard, friable, some odor
-450	44		

TH 78-41

EL	DEPTH (FEET)		DESCRIPTION
-394	00		
		NO TESTING	SANDY SILT dark gray to brown, moderate density, fine to medium sand, some shell fragments
-416	22		
			BEDROCK-Repetto siltstone (Tr)? dark gray, stiff to slightly hard, massive, some foraminifera, slight odor
-462	68		

TH 78-42

EL	DEPTH (FEET)		DESCRIPTION
-422	00		
		NO TESTING	BEDROCK Formation not determined dark gray, stiff to moderately hard, massive, few foraminifera, slight odor
520	98		

TH 78-43

EL	DEPTH (FEET)		DESCRIPTION
-410	00		
		NO TESTING	BEDROCK-Repetto siltstone (Tr)? dark gray, stiff to moderately hard, few foraminifera, slight tendency to be fissile
458	48		

TH 78-50

EL	DEPTH (FEET)		DESCRIPTION
-334	00		
		NO TESTING	MUCK-SILT gray, moderately stiff, some fine sand, pieces pieces of bedrock below 4 2', scattered shells, slight odor
390	56		
			BEDROCK-Malaga mudstone (Tm) dark brown, very stiff to hard, friable, massive, foraminiferal
-445	111		

TH 78-44

DEPTH (FEET)		DESCRIPTION
[illegible]	NO TESTING	BEDROCK Repetto siltstone (Tr) dark gray very stiff to hard friable massive abundant foraminifera slight odor

TH 78-45

DEPTH	SOIL CLASS	10	40	60	100	200	LL	PI	DESCRIPTION
	SP	[illegible]			4	[illegible]	*	NP	SAND gray moderate density shell fragments above 1.9
3									
6	SP	[illegible]	[illegible]	[illegible]		[illegible]	*	NP	
	SM		99	[illegible]		4	*	NP	SILTY SAND, SILT & CLAY gray alternating layers 1" to 1" thick moderate density and stiffness
4									
	ML				99	9?	54	23	SANDY SILT gray moderate stiffness
16.5									

TH 78-46

DEPTH	CLASS	10	40	60	100	200	LL	PI	DESCRIPTION
	CH		99	96	9?	64	35		MUCK CLAY gray to gray brown soft to 2.5 moderately stiff below slight odor
5.2									
6.4									BEDROCK (?) Broken angular rocks in clay matrix

TH 78-47

DEPTH	CLASS	10	40	60	100	200	LL	PI	DESCRIPTION
	CH		99	98	9?	[illegible]	6?	33	MUCK SILT dark gray moderately stiff few shell fragments and angular pebbles to 2" some pieces of soft bedrock below 4.? odorless
	ML		99	95	[illegible]	58	2?		
6.5									BEDROCK Malaga mudstone (Tm) dark gray stiff to moderately hard friable massive foraminiferal slight odor
[illegible]									

TH 78-48

DEPTH		DESCRIPTION
	NO TESTING	MUCK SILT dark gray soft to 2.6 moderately stiff below sandy some pieces of bedrock slight odor
[illegible]		BEDROCK Malaga mudstone (Tm) [illegible] to brown very stiff to moderately hard friable crude bedding dipping 10° to 15° foraminiferal slight odor

TH 78-49

DEPTH	SOIL CLASS	10	40	60	100	200	LL	PI	DESCRIPTION
	MH		99	9?	85	63	23		MUCK SILT gray moderately stiff layered slight odor
									BEDROCK (?)

TH 78-50

DEPTH		DESCRIPTION
	NO TESTING	MUCK SILT gray moderately stiff some fine sand pieces of bedrock below 4.2 scattered shells slight odor
		BEDROCK Malaga mudstone (Tm) dark brown very stiff to hard friable massive foraminiferal

TH 78-51

EL	DEPTH (FEET)		DESCRIPTION
4??		NO TESTING	BEDROCK Repetto siltstone (Tr) dark brown very stiff to hard friable crude bedding dipping near horizontal abundant foraminifera slight odor

TH 78-52

EL	DEPTH (FEET)		DESCRIPTION
[illegible]		NO TESTING	No penetration hard rock at surface

TH 78-53

EL	DEPTH (FEET)	SOIL CLASS	10	40	60	100	200	LL	PI	DESCRIPTION
[illegible]		[illegible]		99	97	90	75	57	33	MUCK CLAY dark gray moderately stiff few thin silty sand layers few shell fragments below 4
42.0	4.9									BEDROCK Repetto siltstone (Tr) dark gray very stiff to hard friable massive foraminifera
4??	[illegible]									

TH 78-54

EL	DEPTH (FEET)	SOIL CLASS	10	40	60	100	200	LL	PI	DESCRIPTION
[illegible]		MH		99	97	89	79	68	32	SILT dark gray moderately stiff [illegible] few shells
??4	5.6									BEDROCK Malaga mudstone (Tm) dark brown very stiff to hard friable [illegible] bedding dips 30° foraminifera [illegible]
47.6	[illegible]									

TH 78-55

EL	DEPTH (FEET)	SOIL CLASS	10	40	60	100	200	LL	PI	DESCRIPTION
37.6	0.0	MH		99	95	79	64	??	44	SILT gray moderately stiff few shells
39.7	[illegible]									BEDROCK Malaga mudstone (Tm)? dark brown stiff to hard friable massive, foraminiferal
42.3	4.?									

TH 78-56

EL	DEPTH (FEET)		DESCRIPTION
39.1	0.0	NO TESTING	BEDROCK Malaga mudstone (Tm) dark brown very stiff to hard friable odorous possible shale below 4
48.3	9.2		

NOTES

1. See plate 1 for location of test holes
2. See sheet 1 for legend, soil classification and [illegible]
3. No bottom sediment analysis was made of test holes 78-33, 34 a[illegible] 38 through 54
4. No mechanical analysis was made of test holes 78-33, 34, 38 [illegible] 44, 48, 50, 51, 52 and 56
5. See plate 4 for description of bedrock symbols

SYMBOL	DESCRIPTIONS	DATE	APPROVAL

REVISIONS

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

NAVIGATION IMPROVEMENT
LA-LB HARBORS, CALIFORNIA
LOS ANGELES HARBOR CHANNEL DEEPENING

LOGS OF TEST HOLES

DESIGNED BY: DRAWN BY: CHECKED BY:
SUBMITTED BY: APPROVED
APPROVAL RECOMMENDED:
SPEC NO. DACW09-
DISTRICT FILE NO.
DATE
SHEET 5 OF 6 SHEETS

2

PLATE 5

TH 78-57

EL (FEET)	DEPTH (FEET)	SOIL CLASS	-10	-40	-60	-100	-200	LL	PI	O&G	Zn	Hg	Pb	Cd	DESCRIPTION
-40.4	0.0														
		SP-SM	91	70	50	11	5	*	NP	133	33	0.1	11	0.2	SAND-SILTY SAND gray moderately dense, many shell fragments
-43.0	2.6														
		SM		100	98	79	43	*	NP	75	65	0.1	11	0.3	SILTY SAND gray, stratified in 3" layers, micaceous
-46.6	6.2														
		ML			100	99	85	39	13	176	84	0.2	13	0.3	SILT AND CLAY gray, moderate stiffness, fine sand in thin layers
-50.4	10.0														
		CL		100	-	93	75	37	16						
-54.0	13.6														
		SP-SM		100	-	51	10	*	NP						SAND-SILTY SAND gray, moderately dense, micaceous
-56.8	16.4														
		SP-SM		100	-	47	10	*	NP						
-60.4	20.0														

TH 78-58

EL (FEET)	DEPTH (FEET)	SOIL CLASS	-10	-40	-60	-100	-200	LL	PI	O&G	Zn	Hg	Pb	Cd	DESCRIPTION
-39.6	0.0														
		ML	99	93	84	71	52	Δ	NP	423	85	0.2	24	0.4	SANDY SILT dark gray, soft
-41.0	1.4														
-42.6	3.0														SILT, SANDY SILT and SILTY SAND gray, indistinctly layered, soft silt, moderately dense silty sand
		ML		100	98	96	78	Δ	NP	142	79	0.1	14	0.3	
-45.6	6.0														
-46.8	7.2														
		CH		100	99	94	77	55	28	98	72	0.1	14	0.3	SAND-CLAYEY SAND gray moderately dense
-48.6	9.0														
		ML		100	99	95	63	Δ	NP	141	72	[illegible]	4	0.3	SILT, SANDY SILT and SILTY SAND same as interval 1.4 to 7.2'
-51.6	12.0														
-59.6	20.0														

TH 78-59

EL (FEET)	DEPTH (FEET)	SOIL CLASS	-10	-40	-60	-100	-200	LL	PI	O&G	Zn	Hg	Pb	Cd	DESCRIPTION
-40.6	0.0														
		CH	100	99	94	92	83	73	39	880	160	0.3	44	1.0	SANDY CLAY dark gray to brown, soft to 1.5' then moderately stiff, rounded gravel to 2" at bottom
-43.1	2.5														BEDROCK-Repetto siltstone (Tr)? gray-brown, very stiff to hard, petroleum odor, foraminiferal
-46.4	5.8														

TH 78-60

EL (FEET)	DEPTH (FEET)	SOIL CLASS	-10	-40	-60	-100	-200	LL	PI	O&G	Zn	Hg	Pb	Cd	DESCRIPTION
-41.3	0.0														
		CH	100	98	94	90	77	55	27	1,030	183	0.5	52	1.2	SANDY CLAY dark gray, soft, odorless
-42.7	1.4														
		ML		100	99	99	78	*	NP	89	64	0.1	11	0.3	SANDY SILT golden brown, dense, unlayered, extremely uniform
-46.3	5.0														
		ML		100	-	99	79	*	NP						
-51.3	10.0														
		ML		100	-	98	67	*	NP						
-56.3	15.0														
-57.6	16.3														

TH 78-61

EL (FEET)	DEPTH (FEET)	SOIL CLASS	-10	-40	-60	-100	-200	LL	PI	O&G	Zn	Hg	Pb	Cd	DESCRIPTION
-42.6	0.0														
		CH	100	98	93	87	75	54	30	1,250	181	0.4	57	0.8	SANDY CLAY dark gray to black, soft to moderate stiffness, odorless
-45.2	2.6														
		CL	93	79	-	67	61	47	22	206	32	0.1	22	0.3	CLAY greenish gray, hard, many shells
-46.5	3.9														
		SP-SM	95	36	-	11	6	*	NP						SAND-SILTY SAND tan, 80% shell fragments
-47.5	4.9														
		ML	100	98	97	96	79	Δ	NP	344	53	0.1	21	0.3	SANDY SILT gray, dense to very dense, generally unlayered except for intervals of shells and shell fragments
-51.6	9.0														
		ML	99	99	-	94	77	Δ	NP						
-57.6	15.0														
-61.8	19.2														

TH 78-62

EL (FEET)	DEPTH (FEET)	SOIL CLASS	-10	-40	-60	-100	-200	LL	PI	O&G	Zn	Hg	Pb	Cd	DESCRIPTION
-31.8	0.0														SILTY SAND dark gray moderate to moderately dense
		SM	100	88	69	37	20	*	NP	373	62	0.2	19	0.3	
-34.9	3.1														
		SP	90	45	-	4	2	*	NP						SAND ght brown and gray, modera dense, shell fragments throughout
-35.8	4.0														
		SP	99	61		4	2	*	NP						
-38.8	7.0														
		SP	98	64		3	2	*	NP						SAND-SILTY SAND gray, 33% course fragments difficult to penetrate
-41.1	9.3														
		SP-SM	67	43	-	19	9	*	NP						
-42.7	10.9														BEDROCK-Repetto siltstone (Tr)? brown mottled very stiff to hard massive, foraminiferal
-46.6	14.8														

TH 78-63

EL (FEET)	DEPTH (FEET)	SOIL CLASS	-10	-40	-60	-100	-200	LL	PI	DESCRIPTION
-23.6	0.0									
		SP-SM	85	67	-	19	8	*	NP	SAND-SILTY SAND brown, many shell fragments
-24.6	1.0									BEDROCK-Repetto siltstone (Tr)? brown very stiff to hard
-34.4	10.8									

TH 78-64

EL (FEET)	DEPTH (FEET)	SOIL CLASS	-10	-40	-60	-100	-200	LL	PI	O&G	Zn	Hg	Pb	Cd	DESCRIPTION
-10.8	0.0														
		SM	97	57	46	36	16	*	NP	3,740	489	0.5	39	0.4	SILTY SAND black, moderately den many shell fragments, occasional strong oily odor
-13.1	2.3														
		SM	99	77	69	55	33	*	NP	667	81	0.3	48	0.3	SILTY SAND gray, very soft and moderately stiff layers
-16.7	5.9														
		SP	99	93	90	60	4	*	NP	131	[illegible]	0.1	6	0.3	SAND gray, moderately dense th layers of shell fragments
-19.8	9.0														
		SP		96	-	62	3	*	NP						
-24.3	13.5														
		SP-SM		100	-	89	11	*	NP						SAND-SILTY SAND same as above e fewer shell fragments
-28.6	17.8														

TH 78-65

EL (FEET)	DEPTH (FEET)	SOIL CLASS	-10	-40	-60	-100	-200	LL	PI	O&G	Zn	Hg	Pb	Cd	DESCRIPTION
-9.7	0.0														
		SM	94	79	57	41	13	*	NP	214	45	0.2	45	0.7	SAND-SILTY SAND black, gray and moderately dense, many shell frag
-11.7	2.0														
		CH	100	99	-	95	90	60	30	1,680	78	0.4	62	0.5	CLAY gray, moderately stiff s H_2S odor
-13.8	4.1														
		SM	97	77	70	53	20	*	NP	268	49	0.2	15	0.3	SILTY SAND gray, moderately de shell fragments throughout
-15.3	5.6														
		SP	98	88	76	50	3	*	NP	194	26	0.1	5	0.2	SAND gray moderately dense to coarse sand and shell fragments 6.1', several thin layers of she fragments throughout
-18.7	9.0														
		SP	99	93	-	44	2	*	NP						
-23.2	13.5														

TH 78-66

EL (FEET)	DEPTH (FEET)	SOIL CLASS	-10	-40	-60	-100	-200	LL	PI	O&G	Zn	Hg	Pb	Cd	DESCRIPTION
-19.3	0.0														
		ML	99	92	90	81	55	Δ	NP	485	92	0.3	27	0.3	SANDY SILT gray, moderately s odorless
-21.7	2.4														
-22.7	3.4														SILTY SAND gray, moderately de
		SP	99	98	-	78	5	*	NP						SAND gray, dense, uniform fin with occasional thin layers of fragments
-26.3	7.0														
		SP		99	-	86	3	*	NP						
-29.5	10.2														

TH 78-67

EL (FEET)	DEPTH (FEET)	SOIL CLASS	-10	-40	-60	-100	-200	LL	PI	O&G	Zn	Hg	Pb	Cd	DESCRIPTION
-15.8	0.0														
		ML	100	99	98	94	80	Δ	NP	891	137	0.3	38	0.5	SANDY SILT gray, moderately small shell fragments througho
-18.0	2.2														
		SM	99	96	94	83	14	*	NP	178	34	0.1	10	0.3	SAND-SILTY SAND gray, modera dense to 8.4' then dense, sil slightly coarser sand and she fragments above 3'
-21.0	5.2														
		SP		99	-	86	3	*	NP						
-25.8	10.0														

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TH 78-62

ANALYSIS (%)	BOTTOM SEDIMENT ANALYSIS (PPM)	DESCRIPTION
* NP	[illegible] 62 0 2 [illegible]	SILTY SAND dark gray moderately loose to moderately dense
2 * NP		SAND [illegible] brown and gray moderately dense shell fragments throughout
* NP		
2 * NP		SAND SILTY SAND gray 33% course shell fragments difficult to penetrate
4 * NP		BEDROCK-Repetto siltstone (Tr)? gray brown mottles very stiff to hard massive foram [illegible]

TH 78-63

ANALYSIS (%) 60 100 200 LL PI	DESCRIPTION
9 8 * NP	SAND SILTY SAND brown many shell fragments
	BEDROCK Repetto siltstone (Tr)? brown very stiff to hard

TH 78-64

ANALYSIS (%) 200 LL PI	BOTTOM SEDIMENT ANALYSIS (PPM) OBG Zn Hg Pb Cd	DESCRIPTION
36 6 * NP	[illegible] 489 0 [illegible] 39 0 4	SILTY SAND black moderately dense many shell fragments occasional trash strong oily odor
55 33 * NP	667 8[illegible] 0 3 49 0 3	SILTY SAND gray very soft and moderately stiff layers
67 4 * NP	3[illegible] [illegible] 0 3	SAND gray moderately dense thin layers of shell fragments
6[illegible] 7 * NP		
89 * NP		SAND SILTY SAND same as above except fewer shell fragments

TH 78-65

ANALYSIS (%) 200 LL PI	BOTTOM SEDIMENT ANALYSIS (PPM) OBG Zn Hg Pb Cd	DESCRIPTION
4 [illegible] * NP	[illegible]4 45 0 2 45 0 7	SAND-SILTY SAND black gray and tan moderately dense many shell fragments
[illegible]	[illegible] 4 6[illegible]	CLAY gray moderately stiff slight H_2S odor
[illegible] * NP	[illegible] 49 2 5 0 3	SILTY SAND gray moderately dense, shell fragments throughout
* NP	14 [illegible] 5 0 2	SAND gray moderately dense to dense, coarse sand and shell fragments 5 6 to 6 1, several thin layers of shell fragments throughout
44 * NP		

TH 78-66

ANALYSIS (%) 200 LL PI	BOTTOM SEDIMENT ANALYSIS (PPM) OBG Zn Hg Pb Cd	DESCRIPTION
[illegible] 55 △ NP	485 32 0 3 27 0 3	SANDY SILT gray, moderately soft, odorless
		SILTY SAND gray, moderately dense
[illegible] 5 * NP		SAND gray, dense, uniform fine sand with occasional thin layers of shell fragments
[illegible] * NP		

TH 78-67

ANALYSIS (%) 60 100 200 LL PI	BOTTOM SEDIMENT ANALYSIS (PPM) OBG Zn Hg Pb Cd	DESCRIPTION
[illegible] 94 80 △ NP	891 137 0 3 38 0 5	SANDY SILT gray, moderately soft, sticky, small shell fragments throughout
4 93 4 * NP	178 34 0 1 10 0 3	SAND SILTY SAND gray, moderately dense to 8 4' then dense, siltier and slightly coarser sand and shell fragments above 3'
66 1 * NP		

TH 78-68

EL DEPTH	MECHANICAL ANALYSIS (%) SOIL CLASS 10 40 60 100 200 LL PI	BOTTOM SEDIMENT ANALYSIS (PPM) OBG Zn Hg Pb Cd	DESCRIPTION
[illegible]	M 100 98 95 93 5 * NP	185 78 0 2 24 0 3	SANDY SILT gray moderately soft, some shell fragments throughout
[illegible]	SM 99 98 89 6 * NP	175 37 0 1 8 0 3	SAND SILTY SAND gray moderately dense to 7 8' then dense very uniform fine sand except slightly siltier with many shell fragments 1 7 to 2 8'
[illegible]	SP-SM 99 92 7 * NP		

TH 78-69

EL DEPTH (FEET)	MECHANICAL ANALYSIS (%) SOIL CLASS 10 40 60 100 200 LL PI	BOTTOM SEDIMENT ANALYSIS (PPM) OBG Zn Hg Pb Cd	DESCRIPTION
[illegible]	ML 100 98 96 94 61 △ NP	526 96 0 2 29 0 3	SANDY SILT gray, moderately soft, some shell fragments throughout, very little odor
[illegible]	SP-SM 99 97 89 12 * NP		SAND SILTY SAND gray, dense, some shell fragments throughout occasionally in thin layers
[illegible]	SP-SM 99 9 8 * NP		

TH 78-70

EL DEPTH (FEET)	MECHANICAL ANALYSIS (%) SOIL CLASS 10 40 60 100 200 LL PI	BOTTOM SEDIMENT ANALYSIS (PPM) OBG Zn Hg Pb Cd	DESCRIPTION
[illegible]	SM 100 99 96 9[illegible] 43 △ NP	625 98 0 2 25 0 3	SILTY SAND gray, moderately dense, some shell fragments throughout
[illegible]	SM [illegible] 96 92 25 * NP	5[illegible] 29 0 [illegible] 7 0 3	SILTY SAND gray, dense, occasional thin layers of shell fragments
[illegible]	SP-SM 99 9 8 * NP		SAND SILTY SAND same as above except slightly less silt

TH 78-71

EL DEPTH (FEET)	MECHANICAL ANALYSIS (%) SOIL CLASS 10 40 60 100 200 LL PI	BOTTOM SEDIMENT ANALYSIS (PPM) OBG Zn Hg Pb Cd	DESCRIPTION
[illegible]	SM [illegible] 99 80 36 △ NP	366 101 0 1 19 0 3	SILTY SAND gray moderately dense to 2 7' then dense, siltier above 2 7'
[illegible]			BEDROCK-Malaga mudstone (Tm)? brown, very stiff to hard, massive
36 [illegible] 15 3			

TH 78-72

EL DEPTH (FEET)	MECHANICAL ANALYSIS (%) SOIL CLASS 10 40 60 100 200 LL PI	BOTTOM SEDIMENT ANALYSIS (PPM) OBG Zn Hg Pb Cd	DESCRIPTION
-32 1 0 0			
	CH 100 96 87 69 40	1,250 190 0 4 51 1 1	CLAY gray, soft, some very fine micaceous sand
36 9 4 8			BEDROCK-Malaga mudstone (Tm)? brown, very stiff to hard
-45 9 13 8			

NOTES

1 See Plate 1 for location of test holes
2 See Sheet 1 for legend, soil classification and general notes
3 No bottom sediment analysis was made of Test Hole 78-63
4 See plate 4 for description of bedrock symbols

SYMBOL	DESCRIPTIONS	DATE	APPROVAL

REVISIONS

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY:
DRAWN BY:
CHECKED BY:

NAVIGATION IMPROVEMENT
LA-LB HARBORS, CALIFORNIA
LOS ANGELES HARBOR CHANNEL DEEPENING

LOGS OF TEST HOLES

SUBMITTED BY: | DATE APPROVED: | SPEC NO DACW09- | DISTRICT FILE NO | SHEET 5 OF 6 SHEETS

PLATE 5

SAFETY PAYS

TH 78-73

EL	DEPTH (FEET)		DESCRIPTION
-38 3	0 0		
		NO TESTING	BEDROCK-Malaga mudstone (Tm)? brown, very stiff to hard
-49 1	10 8		

TH 78-74

EL	DEPTH (FEET)	SOIL CLASS	-10	-40	-60	-100	-200	LL	PI	O&G	Zn	Hg	Pb	Cd	DESCRIPTION
35 3	0 0														
		CH	99	93	83	73	61	59	35	1,850	187	0 8	80	1 2	SANDY CLAY dark gray to brown, moderately soft, shell fragments throughout, very little odor
-38 9	3 6														
		SP	90	67	-	4	2	*	NP						SAND tan to gray, moderately dense, 1 to 1 5' layers, some with many shell fragments.
-42 3	7 0														
		SP	82	44	-	9	2	*	NP						
-45 3	10 0														
		SP	80	32	-	12	4	*	NP						
-48 2	12 9														
		CL		99		99	98	48	23						CLAY light gray stiff to very stiff, unlayered
52 7	17 4														

TH 78-75

EL	DEPTH (FEET)	SOIL CLASS	-10	-40	-60	-100	-200	LL	PI	O&G	Zn	Hg	Pb	Cd	DESCRIPTION
34 2	0 0														
		CH	100	97	-	88	76	67	38	2,410	267	0 7	118	1 6	SANDY CLAY dark gray-brown moderately soft to moderately stiff, very soft 4 4 to 6 3' shell fragments throughout
37 2	3 0														
		CL	97	89	80	69	51	44	21	602	89	0 3	41	0 7	
-40 5	6 3														
		SM	53	42	-	28	13	*	NP	179	35	0 1	18	0 3	SILTY GRAVELLY SAND dark gray brown, loose to moderately dense rounded gravel to 3" maximum diameter
-45 8	11 6														
-47 1	12 9	GP	4	2	-	2	1	*	NP						GRAVEL subround to round, 4" maximum

TH 78-76

EL	DEPTH (FEET)	SOIL CLASS	-10	-40	-60	-100	-200	LL	PI	O&G	Zn	Hg	Pb	Cd	DESCRIPTION
-35 4	0 0														
		CH	100	99	92	84	74	67	35	1,860	449	0 8	190	0 7	SANDY CLAY gray to brown, soft 0 to 2' then moderately stiff unlayered
-40 7	5 3														
		SP	100	93	-	20	4	*	NP						SAND gray, moderately dense to 11' then dense, unlayered
-46 4	11 0														
-48 4	13 0	SP	99	68	-	8	3	*	NP						
		SM		100	96	79	43	*	NP	113	51	0 1	11	0 3	SILTY SAND golden tan, moderately dense, uniform
-51 0	15 6														
		SP	100	89	-	11	3	*	NP						SAND gray to tan, dense, stratified in thin layers
-55 5	20 1														

TH 78-77

EL	DEPTH (FEET)	SOIL CLASS	-10	-40	-60	-100	-200	LL	PI	DESCRIPTION
36 4	0 0									
		SP	100	90	-	10	2	*	NP	SAND gray, moderately dense to dense, 1 to 2 5' layers, many shell fragments 6 8 to 8 1'
40 4	4 0									
		SP	100	73	-	6	1	*	NP	
-44 5	8 1									
45 2	8 8	CL	94	92	-	87	81	47	21	CLAY gray tan, stiff
		ML		100	-	81	53	*	NP	SANDY SILT SILTY SAND golden tan, moderately dense, uniform
48 4	12 0									
		SM		100		74	45	*	NP	
51 4	15 0									
53 9	17 5	SP	100	99		25	3	*	NP	SAND tan to brown, dense, stratified in thin layers
56 4	20 0	SP	100	92		10	3	*	NP	

TH 78-78

EL	DEPTH (FEET)	SOIL CLASS	-10	-40	-60	-100	-200	LL	PI	O&G	Zn	Hg	Pb	Cd	DESCRIPTION
-29 6	0 0														
		CH		100	97	92	84	80	50	3,840	340	1 2	158	1 7	CLAY dark gray brown moderately stiff occasional shell fragments moderate odor
-34 1	4 5														
-36 7	7 1	SP-SM	100	92	66	27	7	*	NP	181	23	0 1	10	0 3	SAND-SILTY SAND gray and brown mottled moderately dense, cleaner and coarser below 6'
		SP	100	79	-	40	2	*	NP						SAND gray tan, moderately dense stratified in thin layers
-41 6	12 0														
		SP	100	89	-	6	3	*	NP						
-48 5	18 9														
-49 6	20 0	SM		100	-	74	42	*	NP						SILTY SAND golden tan moderately de[nse]

TH 78-79

EL	DEPTH (FEET)	SOIL CLASS	-10	-40	-60	-100	-200	LL	PI	O&G	Zn	Hg	Pb	Cd	DESCRIPTION
-38 1	0 0														
		SM	99	90	71	42	23	*	NP	613	88	0 3	32	0 3	SILTY SAND dark gray moderately [illegible] 0 to 1 6' then moderately dense [illegible] brown fine sand 0 to 0 2'
-40 7	2 6														
		SP-SM	100	98	79	42	12	*	NP	75	43	0 1	7	0 2	SILTY SAND light brown moderately [illegible] very subtly stratified in [illegible] layers which vary in silt content
-44 1	6 0														
		SM		100	-	61	32	*	NP						
-48 1	10 0														
		SM		100	-	69	30	*	NP						
-51 1	13 0														

TH 78-80

EL	DEPTH (FEET)	SOIL CLASS	-10	-40	-60	-100	-200	LL	PI	O&G	Zn	Hg	Pb	Cd	DESCRIPTION
-37 6	0 0														
		ML	100	89	72	66	53	Δ	NP	665	100	0 4	39	1 0	SANDY SILT gray to dark brown [illegible] to 3' then moderately dense to dense unlayered
-40 6	3 0														
		ML	99	90	71	70	55	Δ	NP	71	45	0 1	6	0 3	
-44 6	7 0														
		SM	100	87	66	49	33	*	NP	62	39	0 1	7	0 2	SILTY SAND dark brown moderately dense to dense
-48 4	10 8														
-51 1	13 5	CL	100	98		90	84	28	12						CLAY light brown, moderately stiff
-51 9	14 3	SM	100	77		26	17	*	NP						SILTY SAND light brown dense

TH 78-81

EL	DEPTH (FEET)	SOIL CLASS	-10	-40	-60	-100	-200	LL	PI	DESCRIPTION
-39 0	0 0									
		SP	100	59	-	6	2	*	NP	SAND gray and tan, mottled, moderately dense, uniform and unstratified
-44 0	5 0									
		SP	100	77	-	13	3	*	NP	
-49 0	10 0									
		SP	100	78	-	7	3	*	NP	
-54 0	15 0									
		SP	100	81		6	3	*	NP	
-58 5	19 5									

TH 78-82

EL	DEPTH (FEET)	SOIL CLASS	-10	-40	-60	-100	-200	LL	PI	O&G	Zn	Hg	Pb	Cd	DESCRIPTION
-34 4	0 0														
		CL		100	96	89	66	47	22	2,020	201	0 6	80	0 6	SANDY CLAY dark gray brown moder[ately] stiff moderate odor
-37 8	3 4														
		SM		100	98	63	15	*	NP	79	28	0 1	7	0 3	SILTY SAND gray moderately dense occasional shell fragments
-41 6	7 2														
-42 7	8 3														SHELL FRAGMENTS 2' maximum size
		CH		100	99	99	97	59	30	174	93	0 1	35	0 3	CLAY gray moderately stiff unstratified
-45 7	11 3														
-49 1	14 7														
		ML	99	96	-	88	78	Δ	NP						SANDY SILT gray moderately stiff unstratified occasional pebbles to 1 2" maximum diameter
-53 6	19 2														

TH 78-78

Mechanical Analysis (%) -10 -40 -60 -100 -200 LL PI	O&G	Zn	Hg	Pb	Cd	Description
100 97 92 84 80 50	3,840	340	2	158	7	CLAY dark gray brown, moderately stiff occasional shell fragments moderate odor
100 92 66 27 7 * NP	181	23	01	0	03	SAND-SILTY SAND gray and brown, mottled moderately dense, cleaner and coarser below 6'
100 79 - 40 2 * NP						SAND gray-tan, moderately dense, stratified in thin layers
89 - 6 3 * NP						
100 74 42 * NP						SILTY SAND golden tan moderately dense

TH 78-79

Mechanical Analysis (%) -10 -40 -60 -100 -200 LL PI	O&G	Zn	Hg	Pb	Cd	Description
94 90 71 42 23 * NP	613	88	03	32	03	SILTY SAND dark gray, moderately loose 0 to 1.6' then moderately dense, clean brown fine sand 0 to 0.2'
99 98 79 42 2 * NP	75	43	01	7	02	SILTY SAND light brown, moderately dense very subtly stratified in 1 to 1.5' layers which vary in silt content
100 - 6 32 * NP						
100 69 30 * NP						

TH 78-80

Mechanical Analysis (%) -10 -40 -60 -100 -200 LL PI	O&G	Zn	Hg	Pb	Cd	Description
[illegible] 64 55 △ NP	465	100	04	39	10	SANDY SILT gray to dark brown, soft to 3' then moderately dense to dense unlayered
[illegible] 40 [illegible] 55 △ NP	71	45	01	6	03	
100 87 66 44 35 * NP	62	39	0	[illegible]	02	SILTY SAND dark brown, moderately dense to dense
98 - 40 84 28 12						CLAY light brown, moderately stiff
77 - 26 7 * NP						SILTY SAND light brown, dense

TH 78-81

Mechanical Analysis (%) -10 -40 -60 -100 -200 LL PI	Description
59 - 6 2 * NP	SAND gray and tan, mottled, moderately dense, uniform and unstratified
77 - 3 3 * NP	
78 - 7 3 * NP	
81 - 6 3 * NP	

TH 78-82

Mechanical Analysis (%) -4 -6 -200 LL PI	O&G	Zn	Hg	Pb	Cd	Description
[illegible] 66 4[illegible]	1,020	201	06	80	06	SANDY CLAY dark gray-brown, moderately stiff, moderate odor
100 98 63 5 * NP	79	28	01	7	03	SILTY SAND gray, moderately dense occasional shell fragments
						SHELL FRAGMENTS 2" maximum size
[illegible]	174	93	01	35	03	CLAY gray, moderately stiff unstratified
46 88 78 2 NP						SANDY SILT gray, moderately stiff, unstratified, occasional pebbles to 1 2" maximum diameter

TH 78-83

EL	Depth (feet)	Soil Class	Mechanical Analysis (%) -4 -10 -40 -60 -100 -200 LL PI	O&G	Zn	Hg	Pb	Cd	Description
-35.6	0.0								
-39.2	3.6		91 9[illegible] 66 42 18	2,280	152	08	65	07	SANDY CLAY gray, soft 0 to 3.6' then moderately stiff, moderate odor 0 to 3.6' occasional shell fragments 3.6 to 5.9'
-41.5	5.9		100 97 94 75 41 21	196	76	01	14	03	
-44.5	8.9	SM	100 95 77 64 44 △ NP	116	35	01	6	03	SILTY SAND-SANDY SILT gray to 8.2' then greenish gray, moderately stiff, crudely stratified
-47[illegible]	[illegible]	SM	99 9[illegible] 67 51 23 4						
-49[illegible]	[illegible]	SP-SM	98 62 12 7 * NP						SAND-SILTY SAND greenish gray, moderately dense, unstratified
-5[illegible]	[illegible]	SP-SM	55 9[illegible] 7 5 * NP						SILTY GRAVELLY SAND moderately dense, 1/2" maximum
-52[illegible]	[illegible]	SM	100 85 36 19 * NP						SILTY SAND light brown, moderately dense, stratified
-54.4	8.8	SP-SM	100 62 10 6 * NP						SAND-SILTY SAND gold and tan, moderately dense, unstratified

TH 78-84

EL	Depth (feet)	Soil Class	Mechanical Analysis (%) -10 -40 -60 -100 -200 LL PI	O&G	Zn	Hg	Pb	Cd	Description
-37[illegible]	0.0								
-39.3	2.2	ML	99 91 74 54 △ NP	1,240	141	06	55	05	SANDY SILT-SILTY SAND dark gray, moderately dense, occasional shell fragments, odorless
-43.1	6.0	SP-SM	92 75 27 7 * NP	98	19	01	3	02	SAND-SILTY SAND light brown, moderately dense, crudely layered to 11.9' then stratified in thin layers, gravel to 3" diameter at 9.4', abundant shell fragments 10.9 to 11.9'
-4[illegible]	[illegible]0	SP-SM	98 92 85 40 9 * NP	61	20	01	5	02	
-50.4	13.3	SP	97 86 - 40 3 * NP						CLAYEY SAND brown, moderately dense, unstratified, gray and rust colored fine sand at 15.9'
-53.0	15.9	SM-SC	97 95 - 59 30 25 7						

TH 78-85

EL	Depth (feet)	Soil Class	Mechanical Analysis (%) -4 -10 -40 -60 -100 -200 LL PI	O&G	Zn	Hg	Pb	Cd	Description
-34.9	0.0								
-36.2									SANDY SILT dark gray, moderately stiff
-37.9	3.0	SM	99 95 63 62 44 △ NP	500	50	02	18	03	SAND light brown and rust mottled, moderately dense, stratified in thin layers
-40.6	5.7		99 89 28 7 5 * NP	[illegible]	18	01	4	02	
-43.9	9.0	SM	99 98 92 67 29 △ NP	196	37	01	8	03	SILTY SAND light brown and gray, mottled moderately dense, contorted layering
-46.1	11.2		99 99 96 90 41 18	128	100	01	19	03	CLAY light brown, stiff
-49.9	15.0	ML	100 - 87 67 △ NP						SANDY SILT same as interval 5.7 to 9.0 except finer grain size
-54.9	20.0								

TH 78-86

EL	Depth (feet)	Soil Class	Mechanical Analysis (%) -10 -40 -60 -100 -200 LL PI	O&G	Zn	Hg	Pb	Cd	Description
-37.1	0.0								
		CH	100 99 93 71 72 43	7,910	441	11	224	26	CLAY dark gray, moderately soft to 3.8' then moderately stiff to moderate strong odor
-41.6	4.5								
		ML	100 99 △ NP	218	71	01	14	03	SILT gray, moderately stiff to stiff, stratified with very fine sand intervals especially 4.5 to 10.8'
-47.9	10.8								
		ML	100 98 △ NP	132	94	01	21	03	
-51.1	14.0								
-57.1	20.0								

NOTES

1. See Plate 1 for location of test holes
2. See Sheet 1 for legend, soil classification and general notes
3. No bottom sediment analysis was made of test holes 78-38 thru 56, 77 & 81
4. No mechical analysis was made of test hole 78-73
5. See Plate 4 for decription of bedrock symbols

SYMBOL	DESCRIPTIONS	DATE	APPROVAL

REVISIONS

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY:
DRAWN BY:
CHECKED BY:

NAVIGATION IMPROVEMENT
LA-LB HARBORS, CALIFORNIA

LOS ANGELES HARBOR CHANNEL DEEPENING

LOGS OF TEST HOLES

SUBMITTED BY: DATE APPROVED: SPEC. NO. DACW09-____-B-____ DISTRICT FILE NO.

SHEET 6 OF 6 SHEETS

7

APPENDIX G

COST ESTIMATES

COST ESTIMATF

CONTENTS

Figures

COST ESTIMATE

1. Description of Job

The preliminary cost estimate was prepared for the deepening of Los Angeles harbor navigation channels from a 35-foot (MLLW) project depth to a 45-foot (MLLW) project depth. In addition, part of the entrance channel is to be deepened from 45 feet MLLW to 51 feet MLLW by non-federal interest and some of the non-federal basins are to be dredged to 40 feet MLLW. Some clean-up work will also be required to take part of the non-federal project to project depth at 51 feet MLLW. Table 1 summarizes the federal and non-federal dredging quantities, including 1-1/2 feet of overdredging. The total quantity to be removed is 14,707,000 cubic yards. Most of the material is to be disposed of in a 190-acre landfill surrounded by a dike provided by the Harbor Department. The remainder will be disposed of in a shallower water habitat provided as a compensation measure. The landfill will contain 11,707,000 cubic yards to elevation +24 feet MLLW. The shallower water habitat will contain 3,000,000 cubic yards on a shallow slope from MLLW to the existing bottom.

2. Materials

Vibratory cores were taken throughout the area to be dredged in

Table 1 Dredging Quantities

FEDERAL	TO PROJECT DEPTH	1-1/2 FEET OVERDREDGE	TOTAL
WEST BASIN, TURNING BASIN, & EAST CHANNEL	4,052,000	553,000	4,605,000
MAIN CHANNEL	2,019,000	275,000	2,294,000
BEDROCK AREA	1,315,000	179,000	1,494,000
OUTER HARBOR	1,130,000	200,000	1,330,000
TOTAL	8,516,000	1,207,000	9,723,000
NON-FEDERAL			
INNER HARBOR	1,927,000	263,000	2,190,000
BEDROCK AREA	931,000	127,000	1,058,000
OUTER HARBOR	1,476,000	260,000	1,736,000
TOTAL	4,334,000	650,000	4,984,000

TOTAL JOB 14,707,000 cubic yards

1977 and 1978. The logs indicate two primary types of materials that will influence dredgeability. The first type is 12,155,000 cubic yards of an unconsolidated material of silt, clay and sand. The second type is a consolidated compacted clay shale composed of Malaga mudstone and Repetto siltstone, hereafter referred to as bedrock. The total quantity in the bedrock area is 2,552,000 cubic yards including an estimated 246,000 cubic yards of overlying surface sediments. The thickness of surface sediments in the bedrock area varies between zero to six feet. Forty additional cores were taken in 1978, primarily to determine more accurately the quantity and composition of the bedrock.

An exploratory hole was drilled off the pilot station in the main channel. Three standard penetration tests were taken between 50 and 60 feet below MLLW to determine the hardness of the material. The results yielded a fairly consistent blow count of 67 blows per foot, but due to the inefficiency of the drop mechanism, a blow count of N = 60+ was recommended for assessing hardness in the entire bedrock area. Samples of the bedrock could be crushed by fingers and easily scratched with a fingernail.

3. Recent Dredging Experiences

The Los Angeles Harbor Department dredged a 51-foot MLLW channel for the supertanker berths 45 - 47 in 1962 and 1963. That dredging

episode was done by Western Contracting using the 27-inch "Western Eagle" hydraulic dredge and a 5-cubic yard clamshell. The "Western Eagle" used up to 1200 HP in the cutter head, up to 5600 HP in the pump, and 6500 feet of tailpipe. The material was discharged on the beach on the seaward side of the San Pedro Breakwater. The lift was 15 feet. Review of the Daily Dredge Reports indicates that the dredge removed a maximum of 1200 cubic yards per hour and an average of 700 cubic yards per hour in a 16-hour work day. The production decreased at times to as low as 176 cubic yards per hour and was typically less than 400 cubic yards per hour when dredging more than 20 percent bedrock. The remainder of the material was primarily clay. Since this dredging episode, cutterheads have been designed that can cut into bedrock more efficiently, therefore, the same dredge with an improved cutterhead would be expected to get increased production. Several boulders were encountered in the outer harbor area that could not be removed by the clamshell.

West Basin was dredged in 1963 and 1964 by Utah Construction and Mining Co. The 30-inch dredge "Franciscian" pumped over 2,000,000 cubic yards a distance of 12,000 feet to a spoil area that forms the northern border of the proposed landfill. The dredge operated 16 hours per day on a five day work week. This dredging created the basin, and the bulk of work was in a mudflat where little debris was encountered. The dredge had production rates between 2,000 cubic yards per day and

35,000 cubic yards per day. The average production was about 20,000 to 24,000 cubic yards per day. These production rates are probably higher than can be achieved elsewhere in the area because minimal debris was encountered except at Todd Shipyard. Ship interference with dredging activities was also a minor factor in this basin.

With the 27-inch hydraulic dredge "John Franks", Western Pacific dredged the fill for slip 232 in 1978 using only a 1000-foot discharge line. However several unanticipated difficulties were encountered in the dredging area. Pilings from an old pier caused several shutdowns. Several boulders from old revetments and perhaps from ship ballast, railroad ties, cables and other debris were also encountered. Although the vibratory cores taken for this job did not indicate the presence of rock, a very hard, cemented sandstone caused several delays for repairs to the cutter head and ladder. The "Franks" used a 3500 HP pump and a 1500 HP cutter head; however, the ladder was light and bounced off the sandstone. The average production reported in the dredging logs was about 625 cubic yards per hour, ranging from as low as 300 to high as 1320 cubic yards per hour. The average effective working time for the 2-1/2 month project was about 15 hours per day.

In several of the vibratory core samplings taken for the current harbor-deepening project, the corer could not penetrate to the project depth. Hard impenetrable rock was encountered at two locations, one

immediately off the southwest corner of Reservation Point and the other adjacent to the Coast Guard Station. Mr. W.H. Herron, former Chief of the Coastal Engineering Branch, Los Angeles District, Corps of Engineers, recalls accounts of an earlier dredging episode in which hard rock encountered in this area on the eastern side of the channel prevented the dredge from achieving the 35-foot MLLW project depth in this reach. Analysis of the core samples taken for the current project suggests that the inability to achieve full penetration may be attributed to the sampler striking remnants of an old jetty which once extended from Dead Man's Island. An unknown quantity of material similar to that encountered in the slip 232 dredging or off Dead Man's Island may be encountered in the proposed dredging area. A dredge with a heavier ladder and rock-type cutter head should be specified for removing hard material to be anticipated in some parts of the harbor.

The classification of materials is based primarily on vibratory core samples and on one hole where blow counts were taken. The bedrock area should be further investigated by taking additional blow counts to determine more accurately the consistency and hardness of the bedrock material.

4. Debris

The debris encountered by the "Franks" in virgin cuts in the

old harbor may also be anticipated in some areas of the proposed project. Old piers may not be found elsewhere, nor is sandstone expected as a general rule. The "Franks" did achieve good production in most areas. Plate 1 shows a chart of known possible problem areas where more than usual debris may be encountered. The old rubble-mound jetty off Dead Man's Island extended approximately from Bethleham Shipyard to the Coast Guard Station. Remnants of that jetty may be encountered in this area. The old pier near slip 232 was traversed by a railroad. Buried piles, ties, and tracks may be encountered in this area. Remnants of piers may be found where a drawbridge once crossed the entrance to West Basin. Shipyards once used for construction and salvaging of liberty ships as well as the Todd and Bethlehem Shipyards may also be underlain with excessive debris. High concentrations of debris may be encountered near the scrap-metal salvage area. A sunken barge and crane reported to be in the vicinity of berth 192 is believed to be approximately 100 feet from the pier head line in 30 to 38 feet of water. Several other sunken vessels which may interfere with dredging are shown on navigation charts of the harbor to lie off berths 90, 124 and 214. This cost estimate did not include costs for removing these sunken vessels. A more detailed description of the locations and types of vessels would be required to refine these costs.

In addition to these documented areas, other areas may also contain unusual debris. A liberal allowance is made in the cost estimate for

small debris but the cost for removing sunken vessels is not included. Side-scan sonar reveals only surface features, and it is suspected that most of the debris probably sank into the mud where it remains undetected.

Beacuse the commercial channel, with the exception of the East turning basin, the West basin and the channel off slip 232, has not been dredged in the last 40 or more years, even for maintenance, it may be advisable to rake, or "clean-up", the main channel to remove debris prior to dredging operations to minimizing dredge delays and "shut-down" time. The cost estimate does not reflect such a clean-up operation. Raking in areas where high concentrations of debris are suspected, however, raking may be considered economical to some dredgerman.

5. Utilities

Three utility corridors cross the channel, as shown in plate 2. The relocation of these utilities has been accounted for separately and therefore has not been included in this part of the cost estimate.

6. Shipping Interference

Navigation interference with dredging operations should be minimized to decrease waiting times for ship traffic. The average number of ship calls per week is based on the Port of Los Angeles Statement of Revenue

from Operations and Shipping by Berths for the fiscal year ending June 1977. Other types of traffic which do not directly produce revenues for the port, and which must be considered, include tugboat traffic, fishing boats, recreational craft, harbor patrol boats and Coast Guard ships.

Completion of the new Seaside Terminal (Berth 232) is expected before dredging begins and its operations will probably create a local high-traffic area. The cost estimate assumes that the dredge work can be coordinated with ships at berth and that an insignificant downtime should result.

7. Disposal Site

The disposal site comprises a 190-acre landfill and a 190-acre shallower water habitat. The landfill is to be contained on the east and south sides by a new rubble-mound dike. The north and west borders of the landfill are existing rubble-mound dikes that contain earlier landfill projects. The landfill will hold 9,440,000 cubic yards to top-of-dike level at +17 feet MLLW. The landfill is to contain 11,707,000 cubic yards of material. The final grade in the landfill area will be +24 feet MLLW. Dredge material will be used to form a dike to retain the material above the rock dike section.

The shallower water habitat is a fill of 3,000,000 cubic yards on the eastern border of the 190-acre landfill. The compensation measure was devised to create a marine and wildlife habitat with shallower water than is presently available in the vicinity. The habitat is to comprise as clean a sand as is available in the dredging episode. The fill is generally to slope uniformly from MLLW at the eastern containment dike eastward to the existing bottom. The habitat is unconfined on its eastern border. A 1000-foot long breakwater extends eastward from the southern containment dike to contain the material and to protect the habitat from wave erosion.

Several design concepts were considered for constructing the containment dike. It could be a solid rubble structure built independently of the dredging eposide. This has the advantage that the dike work could proceed as a separate bid item. The dike could also be constructed in lifts using the dredge material as part of the foundation for the upperlifts. This reduces the quantity of expensive quarry material, but requires coordination between the dredging and dike work. The cost estimate was based on the latter method assuming that a single contract will be let for the entire project. The southern dike was assumed to be built in two lifts. The first lift comprises a quarry run core and bedding extending from the bottom to -5 feet MLLW plus a sandfill behind it. The sand is to be taken from the Main Channel near Reservation Point or from the outer harbor and placed directly behind the dike.

The second lift comprises quarry run placed over the first lift to elevation +10 feet MLLW, the armor layers from the bottom to +10 MLLW, and the sandfill behind it. Placement of the armor stone must follow closely after placement of the quarry run to prevent waves from destroying the dike as it emerges from the water surface. The sand fill that completes the second lift can be followed by additional filling to the north, providing a base for the east dike. After the east dike has been completed, filling can continue to elevation +17 feet MLLW and the south dike armoring can be completed to that elevation. Eventually, the landfill is completed to elevation +24 MLLW, leaving about a 40 foot berm on all sides at the +17 foot level.

Quarry material can be saved in construction of the east dike by founding the sand fill behind the south dike. Barges used to haul quarry stone draw 12 feet of water. Therefore, the minimum depth at the toe of the dike is designed to be -12 feet MLLW. Construction of the east dike with land-based equipment was considered to be more expensive because it would require rehandling of material and because it would be difficult to operate heavy equipment on the sand and silt fill immediately after its deposition. The construction sequence involves sand filling to elevation -12 feet MLLW along the alinement of the east dike first. Then the quarry run core material is side dumped to about elevation -5 feet MLLW. The dike is then completed with a barge-mounted crane, which places the core and the armor stone to +10 feet MLLW. The remainder of the shallower water habitat east

of the east dike can be completed whenever it is desired to dredge in the areas where the sandy material is located. The job estimate is based on using hydraulic dredges for all excavation. If a mechanical dredge were to be used to remove bedrock, an opening would have to be provided in the east dike to allow rock barges drawing 16 to 18 feet of water to enter the disposal area and deposit their loads. A small section of the eastern dike would be left open to allow for a weir.

The bottom where the south dike is to be built has a one-foot layer of soft, sandy silt overlying a medium to dense fine-sand. The soft surface layer must either be removed or displaced. For the purposes of this design it was assumed that this soft material will be displaced by the rock work during construction and that the structure will rest on a firm sandy bottom.

For purposes of this design, the dikes and the breakwater were assumed to be constructed from rock available on Catalina Island. The cost estimate was prepared assuming a barge haul and floating-plant construction procedure. The dike will comprise three stone types: quarry run for bedding and core construction, "B" stone for underlayers and "A" stone for armor layers. The "A" stone on the southern dike has a nominal weight of 5 tons and is designed for a 10-foot wave height. The side slopes are 1 on 1.5. The eastern dike is protected by the existing Navy mole in Long Beach harbor and by the breakwater that

extends eastward from the southern dike. The armor stone for the southern dike has a nominal weight of one-half tone and is designed to withstand a three-foot design wave. Its toe, at 12 feet MLLW, is sufficiently deep to prevent undercutting if the habitat fill fronting is scoured slightly by the mild wave action in that area.

The least-cost rock source is the Catalina Rock Quarry using barge delivery. The quarry has an economical delivery capacity of approximately 750,000 tons per year. This project requires 854,000 tons of stone. The Long Beach harbor SOHIO project requires about 1,800,000 tons of stone and may run concurrently with the Los Angeles harbor deepening project. Should these two projects occur at the same time, three years could be required to complete stonework in both projects. If it is required to deliver the total of 2,654,000 tons of rock within one 1-1/2 year period, Connolly-Pacific would have to double their output capacity, which would increase rock work costs about 50 percent. Such an increase could amount to about $7,000,000.

8. Pipeline Routes

The disposal area is centrally located relative to the areas to be dredged. The maximum straight-line distance between the disposal site and the dredge area is 12,000 feet. More than half of the area to be dredged is within 6,000 feet of the disposal site. Pipelines

can be routed across Terminal Island in several ways; however, several obstructions including railroad tracks, streets, utilities, driveways, container yards, buildings, oil tanks, etc., pose problems. The objective of routing the pipeline across Terminal Island would be to minimize line lengths and obstructions. The route used for dredging west basin is no longer available because of development on Terminal Island that has occured since that dredging episode.

Plate 2 of the main text shows the proposed routings used for developing this cost estimate. Routings were layed out to minimize cost to the project by consideration of pipeline installation cost and daily operating cost during dredging. Operating cost is minimized by maintaining short pumping distances and by reducing the amount of down-time due to ship interference.

Installation cost is dependent upon where and how the pipeline is placed. Approximate costs for the terrestial lines were obtained as follows: surface line installed on skids--$15 per linear foot; trenched line covered, compacted and paved--$60 per linear foot; and a line bored under railroad tracks or utilities--$240 per linear foot. An additional $100 per linear foot is added for lines bored below the water table.

Aquatic lines can be either floated on pontoons or submerged to rest on the bottom. The advantages of a submerged line over a floating

line are: less pontoons, less interference with navigation, less flexible joints and less down time due to wave action in the harbor. The disadvantage of a submerged line as compared to a floating line is that it cannot be moved around as freely and requires more time to clear if the line should become plugged.

The pipeline route for dredging the entrance channel and outer harbor area is a combination of floating and submerged lines. The total line length would be 7,000 to 10,000 feet. All submerged lines that cross navigation channels must be installed in a trench such that the top of pipe is below the existing project depth.

The route from the disposal area around Reservation Point to a pickup point in the vicinity of slip 232 is for dredging the Main Channel and would require 1200 feet of submerged line.

West Basin, East Basin and the Turning Basin can be dredged using pipeline routes that cross Terminal Island. The proposed route has a main line routed over the surface extending northward from the disposal site across Reeves Field passing to the east of the Federal Building and under the elevated section of the Vincent Thomas Bridge to a "Y" connection at Ocean Avenue. About 300 feet of line would be trenched, backfilled and paved under an off-ramp, under Seaside Boulevard, and under Ocean Avenue. The line would have to be bored under two railroad tracks that parallel Ocean Avenue.

Two lines would join into the main line at the "Y" connection. One of these would run westward along the north side of Ocean Avenue and enter the harbor slightly north of slip 228 adjacent to a fire boat slip. This line would be on the surface for about 2000 feet and trenched for about 400 feet. The second line would run eastward along Ocean Avenue, cross Morman Street and continue eastward for a distance of about 1000 feet. At this point it would bend towards the north, be bored under two railroad tracks and trenched under New Dock Street, under an asphalt access alley, and under Old Dock Street. From this point it would continue along an edge of an automobile storage lot and enter the harbor near slip 215. This line would be used to dredge East Basin, East Basin Channel and Cerritos Channel.

The pipeline routings from the dredge to the shore pick-up points at slip 215 and near slip 228 can be floated along the east and south boundaries of the harbor. After dredging along the east and south boundaries has been completed, submerged lines can be run into East and West Basins across the channel. The lines can surface on a barge.

Alternative routes are possible and have been considered by the Harbor Department. For example, installation cost of the terrestrial pipelines can be avoided by routing a line around Reservation Point for dredging the entire harbor. This however would require 12,000 additional

feet of pipeline and two to three booster pumps, which would increase the daily operating cost. Other pipeline routes across Terminal Island have also been considered but the selected route was chosen to minimize pipeline lengths and obstructions, resulting in the least installation cost.

9. _Dredge Size and Type_

Several methods of dredging could be employed for this project. The most expeditious is the large hydraulic cutter-head suction dredge. A 36 to 42-inch dredge could pump large quantities of material without requiring a booster. If equipped with a heavy ladder and powerful rock cutter-head this dredge could cut through the bedrock area with reasonable production. The disadvantage of a large dredge is its greater daily cost and higher mobilization cost. These factors are offset by the higher production; however, few dredges this large are available. By basing the design on a smaller dredge, say 30 inch or less, the job would attract more bidders. If the dredge is too small, it would not be able to complete the job in a reasonable time nor could it cut the bedrock.

The estimate is based on mobilizing a 24-inch to 27-inch dredge from Portland. Portland was selected for its median mobilization cost, as the contract dredge may come from the Gulf Coast, or as close as San Diego or Sunset Beach. The model dredge was the "McCurdy" using an

8,000 HP barge-mounted booster pump tied directly to the dredge. The "McCurdy" has a 3,500 HP pump with a 600 HP suction jet, a 26-inch suction line, and a 24-inch discharge line. The booster would be required for pipeline lengths over 8,000 feet. The "McCurdy" with its booster could pump sand through a 10,000 foot discharge line at a daily average of about 25,000 cubic yards per 18-to-20-hour day. This production rate exceeds that of the "Franks", which is a 27-inch, 4,000-HP dredge that should get 16,000 cubic yards per day; yet it averaged only 9,000 cubic yards per day on the Slip 232 fill.

The "McCurdy" type dredge with a booster is therefore representative of a medium size 24-inch to 27-inch dredge. In fact, if a 27-inch dredge were used, with 9000 HP pump it would not require a booster, but production could be less than that of the McCurdy with its booster. Several dredges may have to be mobilized to do this job in the given time frame. Assuming a maximum discharge line length of about 15,000 feet and some down time due to debris and ship traffic, one dredge should move about 16,000 cubic yards per day, or 1,000 cubic yards per hour for 16 hours while dredging the unconsolidated material. This phase of the project therefore should require 29 dredge-months. The dredge would operate three, eight-hour shifts or a six day work week.

Although most of the material to be dredged is unconsolidated, a major unknown is the dredgability of 2,552,000 cubic yards of bedrock

and its veneer of overburden. As discussed previously, the bedrock is a mudstone and siltstone. The blow counts in one test hole indicated N=60+ blows per foot. The "Western Eagle" dredged through similiar material, but at a very low productivity. Until clamshell samples or more blow counts are taken, the production rate for this material cannot be reliably predicted.

Recently, Western Pacific attempted to dredge a bedrock material in Coos Bay comprising mudstone; however, they opted not to use a cutterhead. Instead, the bedrock was dredged by a backhoe dredge the "Oski". The "Oski" has an 8-cubic yard bucket which can be replaced by a bedrock ripper when required. The production rate at Coos Bay being limited by the dredgeability of the material was 100 cubic yards per hour for 16 operating hours per day. The material was placed in bottom-dump scows and hauled to sea. The cost was $13 per cubic yard. This job did not include mobilization and demobilization because the dredge was on site. The Coos Bay material was considerably harder than the bedrock in Los Angeles harbor. If the Oski were to be used for the Los Angeles project, production would be limited to the mechanical swing time of the dredge. A production of 200 cubic yards per hour for a 16 hour day would be expected for this special dredge. At this rate the cost would be about $5 to $6 per cubic yard. As previously explained, the material would have to be barged into the landfill disposal area, and for this reason an opening would have to

be left in the dike until all the bedrock not disposable in the lower part of the shallower water habitat was dredged. If additional testing of the bedrock indicates that the material is harder than indicated by current data, the use of a mechanical dredge such as the "Oski" may be necessary. If an opening cannot be left open for barge disposal, the material would have to be rehandled at an increase in cost.

Consideration was given to using a large clamshell dredge or several of them, but the material was considered too hard for efficient clamshell operation without blasting. Blasting in the port area would be controversial, and the material is not so hard that it can not be mechanically or hydraulically removed.

Based on conversations with several contractors and review of the Los Angeles harbor experiences, the clay-shale can be dredged with a hydraulic dredge. Unless this rock is harder than expected, a 27" dredge with a rock-type cutter-head with a heavy ladder and over 1200 HP in the cutter drive should be able to remove between 300 and 800 cubic yards per hour. The limiting factor is the cutting ability of the dredge. Pumping should be relatively easy with the low cutting rates. A production rate of 500 cubic yards per hour for a 16-hour day was considered reasonable for use in the cost estimate. A booster would not be required because of the short pumping distance.

This bedrock dredging phase of the project would therefore require 12 dredge-months.

In order to complete the job in 2-1/2 years, the cost estimate is based on mobilizing two dredges, a standard 24-inch to 27-inch dredge with booster to remove the unconsolidated material and a modified 24-inch to 27-inch dredge to remove the bedrock. The dredge used for the bedrock would become free to assist the other dredge to complete the schedule in 26 months, assuming a combined rate of 28,000 cubic yards per day for the two dredges. The dredge used primarily for the bedrock was assummed to have a production rate of 12,000 cubic yards per day while dredging unconsolidated material, because a booster was not included.

10. Dredging Plan

The plan for building the dikes and dredging the harbor requires coordination between dike construction and dredging operations. The mobilization of the dredges can take two to three months, whereas the rock work could start within a month after contract award. While the dredges are being mobilized, the first lift of rock work on the south dike would be initiated. Based on a five day work week for rock work, the first lift, including the breakwater, would take about two and one half months. The first lift would be nearing completion when the dredges would be available to start pumping. The first

dredging episode would be in the main channel where silty sand and sandy silt is located. This material could be placed in the first lift behind the initial quarry run dike built to -5 feet MLLW. This episode would take three weeks to pump 288,000 cubic yards. The second dredge would concurrently initiate dredging in the bedrock area. Bedrock spoil would first be disposed of in the northwest corner of the landfill. This episode would take about 13 months to fill an average depth of eight feet. Silt curtains may be necessary to preserve water quality standards but the material should settle out rapidly over a 5000 foot radius, and temporary dikes would not be required. The dike work would then continue by placing the second lift of quarry run, underlayer and armor stone to +10-foot MLLW elevation.

As previously explained, placement of the armor stone must follow closely behind the second quarry run lift. The time required to complete this second lift, underlayer and armor would be about six months. Completion of the breakwater would require an additional three months.

The first dredge, after completing the first sand lift behind the quarry run in the south dike, would dredge the relatively course material from the inner and outer harbor to construct the sandfill comprising the first lift of the east dike. This first lift requires 330,000 cubic yards, assuming the material rests on a 1:10 slope, and should take about a month. It can be done any time before the rock is placed in the second lift on the east dike. The east-dike

rock work can begin after the south dike is completed to elevation +10 MLLW and the breakwater is completed. It could then be completed within three months. The coarser sand in the harbor should be used for the second-lift backfills behind the east and south dikes. A total of about 900,000 cubic yards of sand backfill would be required, assuming a minimum 10-foot crest width and 1:10 side slopes. This operation should take about two months. The rock work will require an additional month to complete to bring the elevation of the south dike to +17 feet MLLW. Sixteen months after start of construction, the rock work should be completed.

The remaining work items are the dredging of the upper reaches of the inner harbor and the remainder of the outer harbor and construction of the shallower water habitat. The habitat can be constructed using finer material in a base course and overlaying the base course with a sandy material from the main channel or outer harbor. Dredging the outer harbor can proceed during the summer months when low wave activity should present the least problems to the dredge.

Sixteen months after contract award, 6,656,000 cubic yards of unconsolidated material should remain to be dredged. This must be done within 14 months to meet the 30 month project schedule. The dredge with the booster can pump 5,824,000 cubic yards in this time, leaving 832,000 cubic yards to be pumped by the second dredge. The second dredge would be confined to shorter pumping distances with a

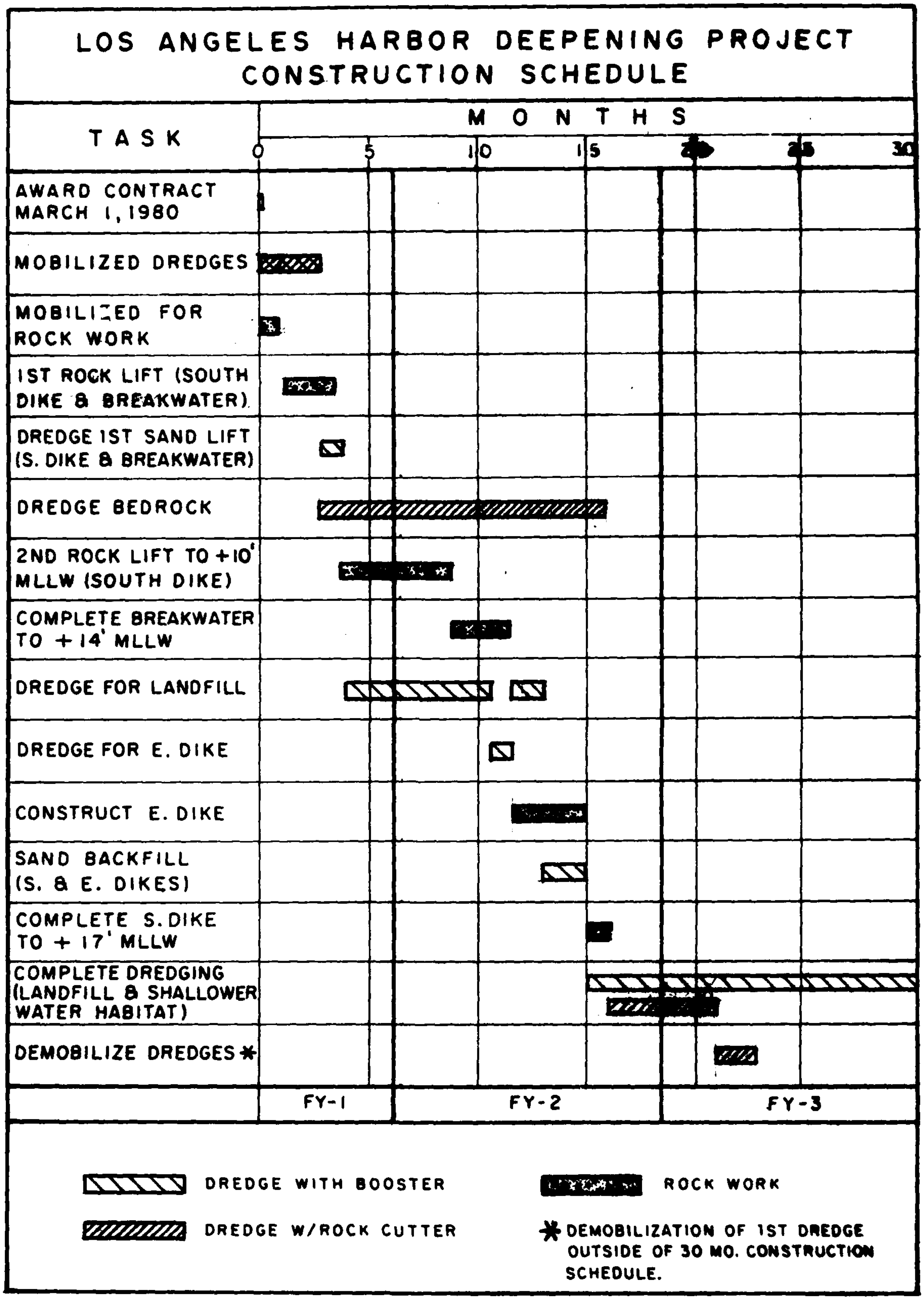
lower production rate unless a booster were used. Assuming a production rate of 12,000 cubic yards per day for a 6,000-to 8,000-foot pumping distance, the second dredge could complete the 832,000 cubic yards in three months. This dredge could then be released or continued in service with the first dredge to complete the job in less than 30 months.

Completion of dredging will raise the landfill to about elevation +24 feet MLLW, however the armoured containment dikes will rise only to +17 feet MLLW on the southern border and to +12 feet MLLW on the eastern border. Therefore, dredged material must be used to form a containment dike above the elevation of the armored dike. The dredged-material dikes can be formed by control of the discharge or by dozers or draglines working on the fill.

This plan was predicated on the use of certain dredges. Larger more powerful dredges exist; however, their pumping rates could be limited as a result of down time for debris and reduced efficiency in cutting the bedrock. The production rates are reasonable, but they could be improved upon, and a single larger dredge may be able to accomplish the work within the specified time. The construction schedule is shown on the following chart.

11. Estimate Assumptions, General

1. Bedrock comprising mudstone and siltstone and a veneer of overburden to be removed by hydraulic cutter-head dredge: 2,552,000 cubic yards.


LOS ANGELES HARBOR DEEPENING PROJECT
CONSTRUCTION SCHEDULE
TASK
MONTHS
0
5
10
15
20
25
30
AWARD CONTRACT MARCH 1, 1980
MOBILIZED DREDGES
MOBILIZED FOR ROCK WORK
1ST ROCK LIFT (SOUTH DIKE & BREAKWATER)
DREDGE 1ST SAND LIFT (S. DIKE & BREAKWATER)
DREDGE BEDROCK
2ND ROCK LIFT TO +10' MLLW (SOUTH DIKE)
COMPLETE BREAKWATER TO + 14' MLLW
DREDGE FOR LANDFILL
DREDGE FOR E. DIKE
CONSTRUCT E. DIKE
SAND BACKFILL (S. & E. DIKES)
COMPLETE S. DIKE TO + 17' MLLW
COMPLETE DREDGING (LANDFILL & SHALLOWER WATER HABITAT)
DEMOBILIZE DREDGES *
FY-1
FY-2
FY-3
DREDGE WITH BOOSTER
ROCK WORK
DREDGE W/ROCK CUTTER
* DEMOBILIZATION OF 1ST DREDGE OUTSIDE OF 30 MO. CONSTRUCTION SCHEDULE.

2. Sand, silt and clay to be removed by hydraulic cutter-head dredge: 12,155,000 cubic yards.

3. Discharge pipe will generally be submerged on the -45 MLLW foot bottom and thus will not interfere with existing ship traffic. Also, the contractor will not be required to move or break his floating discharge line because of ship traffic except in special cases where he is dredging near a berth.

4. The booster will follow the dredge, or have a permanently assigned berth at no extra cost to the contractor for power hook-up.

5. All land-side right-of-ways for discharge pipe routed across Terminal Island will be provided by the Harbor Department.

6. The Harbor Department will provide at no cost to the contractor a berth for dredge mobilization and demobilization and a service yard from which the contractor may operate during the contract period.

7. All permits are assumed to be "in-hand", and no lost time will be encountered because of environmental restrictions not specifically set forth in the contract specifications.

8. Weather is acceptable and satisfactory for normal dredging operations in the "outer-harbor" and outside the breakwater at least 9 months during each year.

9. October, 1979 price levels were used.

10. The dike design was based on a ten-foot design wave. This criterion was established by the Harbor Department.

11. All dike designs are preliminary for cost estimating purposes and require more detailed analyses for design-wave impact, soil properties and seismic considerations.

DATE
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